INDUSTRY PROCESS
AND AUTOMATION SOLUTIONS

BONFIGLIOLI VECTRON

Expansion Module EM-ABS-01

Frequency Inverter 230 V / 400 V

ACTIVE Cube

GB

BONFIGLIOLI

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1 General Information about the Documentation

The present supplement to the operating instructions is valid for the frequency inverters of the ACU series of devices. The information necessary for the assembly and application of the EM-ABS-01 extension module is documented in this guidance.
For better clarity, the documentation is structured according to the customer-specific requirements made on the frequency inverter.

1.1 Instructions

For better clarity, the documentation is structured according to the customer-specific requirements made on the frequency inverter.

Quick Start Guide

The Quick Start Guide describes the basic steps required for mechanical and electrical installation of the frequency inverter. The guided commissioning supports you in the selection of necessary parameters and the configuration of the frequency inverter by the software.

User manual

The Operating Instructions describe and document all functions of the frequency inverter. The parameters required for adapting the frequency inverter to specific applications as well as the wide range of additional functions are described in detail.

Application Manual

The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. Information on various subjects connected with the use of the frequency inverter are described specific to the application.
If you need a copy of the documentation or additional information, contact your local representative of BONFIGLIOLI.
The present documentation was prepared with great care and it was subjected to extensive and repeated reviews. For reasons of clarity, it was not possible to include all details of all types of the product in the documentation. Neither was it possible to consider all conceivable installation, operation or maintenance situations. If you require further information or if you meet with specific problems which are not dealt with in sufficient detail in the documentation, contact your local BONFIGLIOLI agent.
We would also like to point out that the contents of this documentation do not form part of any previous or existing agreement, assurance or legal relationship. Neither are they intended to supplement or replace such agreements, assurances or legal relationships. Any obligations of the manufacturer shall solely be based on the relevant purchase agreement which also includes the complete and solely valid warranty stipulations. These contractual warranty provisions are neither extended nor limited by the specifications contained in this documentation.
The manufacturer reserves the right to correct or amend the specifications, product information and omissions in these operating instructions without notice. The manufacturer shall not be liable for any damage, injuries or costs which may be caused by the aforementioned reasons.
The present instructions were issued in German language. Other language versions are translations of the German document.

1.2 Pictograms and signal words used

The following pictograms and signal words are used in the documentation:

Danger!

Danger refers to an immediate threat. Non-compliance with the precaution described may result in death, serious injury or material damage.

Warning!

Warning refers to a possible threat. Non-compliance with the warning may result in death, serious injury or material damage.

Caution!

Caution refers to an indirect threat. Non-compliance may result in personal or material damage.

Attention!
Attention refers to a possible operational behavior or an undesired condition that can occur in accordance with the reference text.

Note
Note marks information that facilitates handling for you and supplements the corresponding part of the documentation.

1.3 Copyright

This user manual is protected by copyright. It is solely intended for use by operating staff and must not be copied nor disclosed to third parties.

2 General Safety Instructions and Information on Use

Warning!

The specifications and instructions contained in the documentation must be complied with strictly during installation and commissioning. Before starting the relevant activity, read the documentation carefully and comply with the safety instructions. The term "Qualified Staff" refers to anybody who is familiar with the installation, assembly, commissioning and operation of the frequency inverter and has the proper qualification for the job.

2.1 General Information

Warning!

The DC-link circuit of the frequency inverter is charged during operation, i.e. there is always the risk of contact with high voltage. Frequency inverters are used for driving moving parts and they may become hot at the surface during operation.

Any unauthorized removal of the necessary covers, improper use, wrong installation or operation may result in serious injuries or material damage.

In order to avoid such injuries or damage, only qualified technical staff may carry out the transport, installation, commissioning, setup or maintenance work required. The standards DIN EN 50178, IEC 60364 (Cenelec HD 384 or DIN VDE 0100), IEC 60664-1 (Cenelec HD 625 or VDE 0110-1), BGV A2 (VBG 4) as well as the applicable national regulations must be complied with. The term „Qualified Staff" refers to anybody who is familiar with the installation, assembly, commissioning and operation of the frequency inverter as well as the possible hazards and has the proper qualification for the job.

Persons not familiar with the operation of the frequency inverter or children must not have access to the device.

2.2 Designated use

Warning!

The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of operation is not allowed until it has been verified that the machine meets the requirements of the EC Machinery Directive 2006/42/EEC and DIN EN 60204. In accordance with the CE marking requirements, the frequency inverters comply with the Low Voltage Directive 2006/95/EEC as well as DIN EN 61800-5-1. The user shall be responsible for making sure that the requirements of the EMC Directive 2004/108/EEC are met. Frequency inverters are only available at specialized dealers and are exclusively intended for professional use as per DIN EN 61000-3-2.

Any use other than the use described above, will be considered as not in accordance with the specified purpose and may result in the warranty becoming null and void.

The frequency inverters are also marked with the UL label according to UL508c, which proves that they also meet the requirements of the CSA Standard C22.2-No. 14-95.

The technical data, connection specifications and information on ambient conditions are indicated on the rating plate and in the documentation and must be complied with in any case. Anyone involved in any kind of work at the device must have read the instructions carefully and understood them before starting the work.

2.3 Transport and Storage

The frequency inverters must be transported and stored in an appropriate way. During transport and storage the devices must remain in their original packaging.
The units may only be stored in dry rooms which are protected against dust and moisture and are exposed to little temperature deviations only. Observe the conditions as per DIN EN 60721-3-1 for storage, DIN EN 60721-3-2 for transport and the labeling on the packaging.
The duration of storage without connection to the permissible nominal voltage may not exceed one year.

2.4 Handling and installation

Warning!

Damaged or destroyed components must not be put into operation because they may be a health hazard.

The frequency inverters are to be used in accordance with the documentation as well as the applicable directives and standards.
It must be handled carefully and protected against mechanical stress.
Do not bend any components or change the isolating distances.
Do not touch electronic components or contacts. The devices are equipped with components which are sensitive to electrostatic energy and can be damaged if handled improperly. Any use of damaged or destroyed components shall be considered as a non-compliance with the applicable standards.
Removal of seals from the housing can result in invalidation of warranty.
Do not remove any warning signs from the device.

2.5 Electrical Installation

Warning!

Before any assembly or connection work, discharge the frequency inverter. Verify safe isolation from power supply.

Do not touch the terminals because the capacitors may still be charged.

Comply with the information given in the operating instructions and on the frequency inverter label.

Follow the safety rules applying to work on electrical equipment.

Follow the safety rules applying to work on electrical equipment:

- Isolate: Isolate the installation from all possible sources of electrical power.
- Secure against reconnection. Only the persons working on the installation may re-commission the relevant part of the installation.
- Verify there is no electrical power: Using a measuring instrument or voltage tester, ensure there is no voltage against ground on the relevant plant component.
- Ground and short-circuit: Starting from the ground terminal, connect all conductors to one another.[1)]
- Cover und shield neighboring live parts: By covering, shielding or isolation of energized plant components contact with such parts is to be prevented.

1) Deviations from this are possible in certain circumstances.

When working at the frequency inverters, comply with the relevant accident prevention regulations, the applicable standards BGV A2 (VBG 4), VDE 0100, standards governing work on systems with dangerous voltages (e.g. DIN EN 50178) and other national directives.

Comply with the electrical installation instructions given in the documentation as well as the relevant directives.
Responsibility for compliance with and examination of the limit values of the EMC product norm DIN EN 61800-3 for variable-speed electrical drive mechanisms is with the manufacturer of the industrial plant or machine. The documentation contains information on EMC-conforming installation.
The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
Do not connect any capacitive loads.

2.6 Information on Use

Warning!

The frequency inverter may be connected to power supply every 60 s. This must be considered when operating a mains contactor in jog operation mode. For commissioning or after an emergency stop, a non-recurrent, direct restart is permissible.

After a failure and restoration of the power supply, the motor may start unexpectedly if the AutoStart function is activated.

If staff is endangered, a restart of the motor must be prevented by means of external circuitry.

Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to DIN EN 60204 and applicable the safety directives (e.g. Working Machines Act, Accident Prevention Directives etc.).

No connection work may be performed, while the system is in operation.

2.6.1 Operation with products from other manufacturers

Please note that Bonfiglioli Vectron will not accept responsibility for compatibility with products from other manufacturers (e.g. motors, cables, filters, etc.).
In order to achieve optimum system compatibility, Bonfiglioli Vectron offers components which ensure easy commissioning and are perfectly adjusted to one another in operation.
Use of the device with products from other manufacturers will be at your own risk.

2.7 Maintenance and service

Warning!

Unauthorized opening and improper interventions can lead to personal injury or material damage. Repairs on the frequency inverters may only be carried out by the manufacturer or persons authorized by the manufacturer.

Check protective equipment regularly.

Any repair work must be carried out by qualified electricians.

2.8 Disposal

The components of the frequency inverter must be disposed of in accordance with the applicable local and national laws, regulations and standards.

3 Introduction

This document describes the possibilities and the properties of the EM-ABS-01 extension module for the frequency inverters of the ACU series of devices.

Note: This document exclusively describes the EM-ABS-01 extension module. It is not to be understood as fundamental information for the operation of the frequency inverters of the ACU series of devices.

The EM-ABS-01 extension module is an optional hardware component to extend the functionality of the frequency inverter. It enables the data exchange within the network and between the components which have been directly connected, for example control and regulation elements.

An absolute value encoder or a SinCos encoder and an external DC 24 V power source can be connected to the extension module EM-ABS-01. The connected voltage source can power the encoder. To that end, the encoder power supply must be set to "Via X410A" via a parameter (Parameter *Power Supply* **1186**, see chapter 8.4.3 Power supply). The voltage level for encoder power supply can be set via a parameter (Parameter *Supply voltage* **1187**, see Chapter 8.4.4 "Supply voltage"). The voltage value can be controlled via a measuring cable (often referred to as "sense" cable).

The EM-ABS-01 extension module extends the functionality of the frequency inverters of the ACU series of devices by the following functions:

- System bus CAN
  (Can interface ISO-DIS 11898, CAN High Speed, max. 1 MBaud).
  See chapter 7 "System bus".
- Analog input DC -10…+10 V or DC 0…+10 V.
  See chapter 8.1 "Analog input EM S1INA".
- Encoder interface including PTC evaluation via HD-Sub-D female connector.
  Supported encoder types:
  - SinCos (optionally with commutation tracks for synchronous motors)
  - EnDat 2.1 (encoder type with SinCos track required)
  - Hiperface
  - Being prepared: SSI encoder (optionally with TTL [RS-422]- or SinCos track)

  See chapter 8.4 "Encoder input EM".
- Three digital inputs.
  See chapter 8.3 "Digital inputs EM-SxIND".
- Two digital outputs, can also be used as repetition frequency output.
  See chapter 8.2 "Digital outputs EM-S1OUTD and EM-S2OUTD".
- Adjustable voltage output for encoder supply.
  See chapter 8.4.3 "Power supply" and 8.4.4 "Supply voltage".
- DC 24 V voltage input for connection of external power supply. Via this input a connected encoder can be powered.
  See chapter 5.3.3 "Power supply" 8.4.3 "Power supply".

Note: Depending on the motor and encoder type used there are restrictions as to usability in applications. See chapter 3.2 "Range of applications of encoders".

Note: The EM-ABS-01 extension module has been enclosed with the frequency inverter as a separate component and must be fitted by the user. This is described in the chapter 5.2 "Mechanical Installation".

The extension module is assembled simply by plugging on without tools being needed thanks to the modular set-up of the frequency inverters of the ACU series of devices.

Caution! Carry out the assembly of the extension module before the frequency inverter is put into operation, and only in a voltage-free state.

The plug-type terminals of the extension module enable economical overall fitting with a safe function.

Note: Chapter 10.2 contains a compatibility list of the EM-ABS-01 modules in combination with the ACU inverter firmware versions.

3.1 Restrictions for operation of standard functions

Note: If an EM-ABS-01 module is used with an ACU device, the following functions of the basic device can no longer be used:

- Repetition frequency mode via MFO1 of base device.
  Instead, repetition frequency mode can be realized via digital outputs of the EM-ABS-01 module.

- Repetition frequency mode (also PWM frequency input) via digital inputs of basic device
  Instead, the speed sensor 1 input of the basic device can be used.

3.2 Range of applications of encoders

Depending on the motor and encoder type used there are restrictions as to usability in applications. The following sections describe the range of applications.

Note: The EM-ABS-01 module supports, in the case of EnDat 2.1 encoders, a baud rate of 100 kBit/s. Other baud rates will not be supported.

3.2.1 Asynchronous motor

SinCos,
Hiperface,
EnDat 2.1 with SinCos track,
SSI with incremental track (TTL [RS-422] or SinCos)
can be used on asynchronous motors as:

- Motor encoders for speed feedback (e.g. Configuration 210)
- Motor encoders for speed feedback and parallel position feedback in non-slip systems (e.g. Configuration 240)
- Application encoder for position feedback with parallel speed feedback either via motor model (sensorless e.g. Configuration 440) or via HTL encoder (via terminals on ACU basic device e.g. Configuration 240).

SSI encoders without incremental track
can be used on asynchronous motors as:

- Application encoder for position feedback with speed feedback either via motor model (sensorless e.g. Configuration 440) or via HTL encoder (via terminals on ACU basic device e.g. Configuration 240).

EnDat 2.1 without SinCos track
cannot be used.

3.2.2 Synchronous motor

SinCos with commutation tracks,
Hiperface,
EnDat 2.1 with SinCos track,
SSI with incremental track (TTL [RS-422] or SinCos)
can be used on synchronous motors as:

- Motor encoders for speed feedback (e.g. Configuration 510).
- Motor encoders for speed feedback and parallel position feedback in non-slip systems (e.g. Configuration 540).
- Application encoder for position feedback with parallel speed feedback via motor model (sensorless e.g. Configuration 640) .

SinCos without commutation track,
SSI encoders without incremental track
can be used on synchronous motors as:

- Application encoder for position feedback with parallel speed feedback via motor model (sensorless e.g. Configuration 640) .

EnDat 2.1 without SinCos track
cannot be used.

4 Technical data

When using the EM-ABS-01 extension module, the technical data of the frequency inverter must be considered.

Control terminal X410A	
X410A.1	Voltage input DC 24 V
X410A.2	Ground DC 24 V
X410A.3	Digital output EM-S1OUTD[1), 2)]
X410A.4	Digital output EM-S2OUTD[1), 2)]
X410A.5	Voltage output DC 5…12 V[3)]
X410A.6	Analog input EM-S1INA[1)]
X410A.7	Ground DC 10 V

Control terminal X410B	
X410B.1	Ground
X410B.2	Digital input EM-S1IND[1)]
X410B.3	Digital input EM-S2IND[1)]
X410B.4	Digital input EM-S3IND[1)]
X410B.5	System bus, CAN low
X410B.6	System bus, CAN high
X410B.7	Ground

1) The control electronics parameters can be configured as required.
2) Can be used as repetition frequency output. The repetition frequency output can withstand external voltage in a range from -5 V to +10 V.
3) The max. power available is reduced by the other control outputs of the frequency inverter and extension module.

Caution! The input for external DC 24 V voltage supply can withstand external voltage up to DC 30 V. Avoid higher voltage levels. Higher voltages may destroy the module.

Caution! The power output on terminal X410A.1 may be loaded with a maximum power of 2 W. Higher power levels can damage components of the module.

Encoder and PTC input X412 (HD-Sub-D)	
Encoder input:	**PTC input**
Internal resistance <100 Ω	Trigger resistance = 2.4 kΩ according to DIN 44081
A/B and C/D track: sine-shaped differential signal 0.6…1.2 Vss	Hysteresis = 1.3 kΩ
	PTC or bimetal temperature sensor (NC)
R-track: Differential signal 0.2…1.7 Vss	
Clock and data (alternative to C/D track) Signal: V =DC 2.5 V ±0.5 V	
Power supply encoder: V_{ENC} track: Supply DC 5…12 V $V_{ENC,Sense}$ track: encoder sensor cable	

Warning! The PTC input is not insulated. Only PTCs which feature a safe isolation from the motor winding as per EN61800-5-1 may be connected.

Note: BONFIGLIOLI servo motors of types BCR and BTD are provided with safe isolation to the motor winding.

Note: BONFIGLIOLI VECTRON recommends connecting an external power supply to the voltage input of the control terminal. This auxiliary voltage enables powering an encoder via the voltage output of the control terminal. Note the manufacturer's input power specifications of the encoder.

Technical data of control terminals
Digital inputs (X410B.2) … (X210B.4): Low Signal: DC 0 V …3 V, High Signal: DC 12 V … 30 V, input resistance: 2.3 kΩ, PLC compatible Sample Times: 1 ms in configurations x40 ("Positioning") 4 ms in all other configurations Frequency signal: DC 0 to 30 V, 10 mA at DC 24 V, f_{max} = 150 kHz
Digital outputs (X410A.3), (X410A.4): Low signal: DC 0 V to 3 V, High signal: DC 12 V to 30 V, output current: 40 mA, PLC compatible, Repetition frequency output: frequency signal , F_{max} = 150 kHz, overload and short-circuit proof, I_{max} = ±60 mA at min. permissible line termination 150 Ω, according to specification EIA485
Analog input (X410A.6): Analog signal: Input voltage: DC -10 V to 10 V / DC 0 V to 10 V (R_i = 100 kΩ), Resolution 13 Bit
Voltage output DC 5 to 12 V for encoder supply (X410A.5): P_{max} = 2 W. Depending on the load on the digital outputs of the frequency inverter and extension module, this value may be lower.
Voltage input DC 24 V for external power supply (X410A.1) Input voltage range DC 24 V ±10%, U_{max} = DC 30 V, Rated input current: max. DC 1.0 A (typical DC 0.45 A), Peak inrush current: typical: < DC 20 A, External fuse: standard fuse elements for rated current, characteristic: slow, Safety: Safety extra low voltage (SELV) according to EN 61800-5-1
Conductor cross-section: The control terminals are suitable for the following cable sizes: with ferrule: 0.25 … 1.0 mm² without ferrule: 0.14 … 1.5 mm²

5 Installation

5.1 General

The mechanical and electrical installation of the EM-ABS-01 extension module must be carried out by qualified personnel according to the general and regional safety and installation directives. For a safe operation of the frequency inverter it is necessary that the documentation and the device specifications be complied with during installation and commissioning. In the case of special applications, you may also have to comply with further guidelines and instructions.

The frequency inverters are designed according to the requirements and limit values of product norm EN 61800-3 with an interference immunity factor (EMI) for operation in industrial applications. The electromagnetic interference is to be avoided by expert installation and observation of the specific product information.

For further information, refer to the chapter "Electrical Installation" of the frequency inverter operating instructions.

Warning! All connection terminals where dangerous voltage levels may be present (e.g. motor connection terminals, mains terminals, fuse connection terminals, etc.), must be protected against direct contact.

5.2 Mechanical Installation

Danger! If the following instructions are not complied with, there is direct danger with the possible consequences of death or severe injury by electrical current. Further, failure to comply can lead to destruction of the frequency inverter and/or of the extension module.

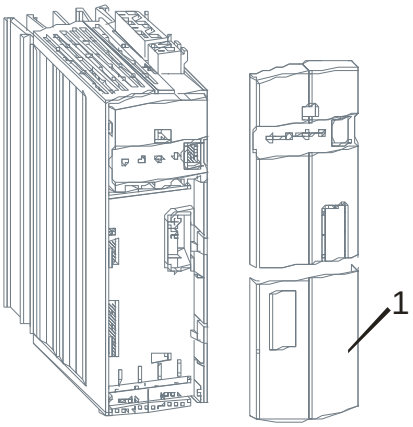
- Before assembly or disassembly of the EM-ABS-01 extension module, the frequency inverter must be de-energized. Take appropriate measures to make sure it is not energized unintentionally.
- Make sure that the frequency inverter is discharged.

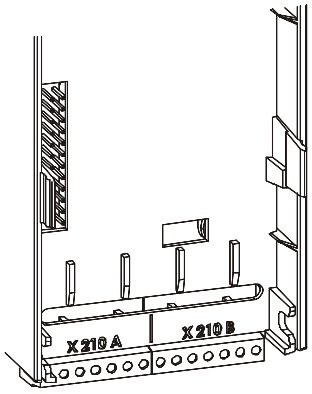
Danger! When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Wait for at least three minutes until the DC link capacitors have discharged before starting to work at the unit.

The EM-ABS-01 extension module is supplied in a housing for assembly on the lower slot of the frequency inverter.

- Remove the lower cover (**1**) of the frequency inverter.

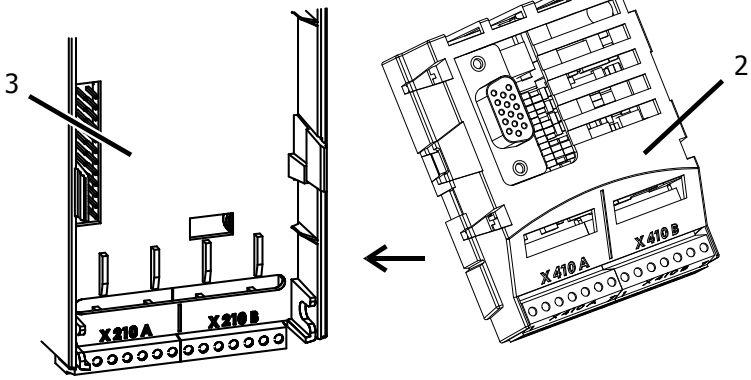
The slot for the EM-ABS-01 extension module becomes accessible.





Caution! The EM-ABS-01 (**2**) extension module is pre-fitted in a housing. The PCB visible on the back may not be touched, as modules can be damaged by this.

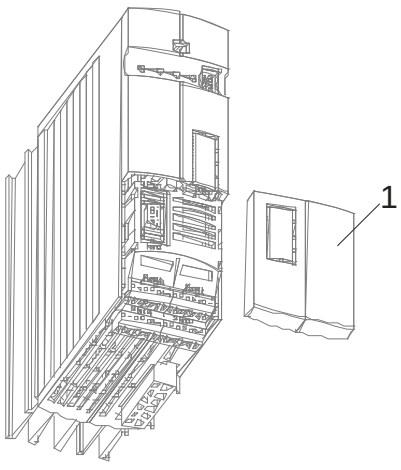
- Plug the EM-ABS-01 (**2**) extension module onto the slot (**3**).



- Re-install the lower cover (**1**).

Assembly is complete.

When the supply voltage of the frequency inverter is switched on, the EM-ABS-01 ex-tension module is ready for operation.



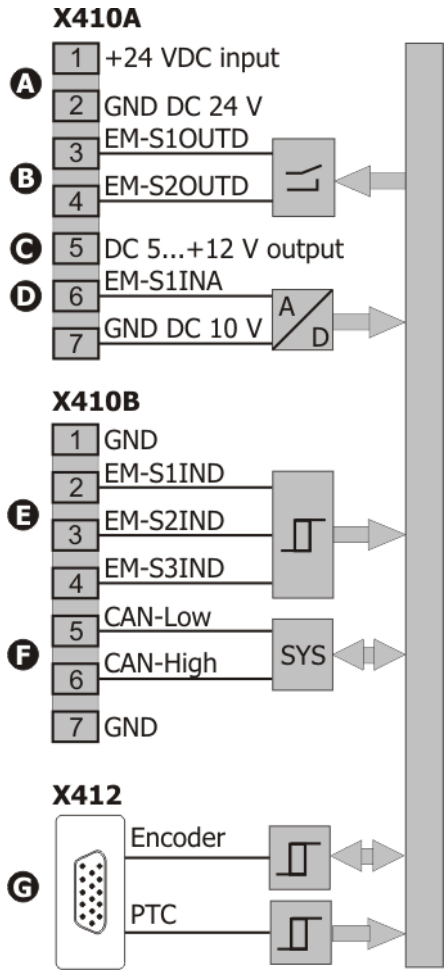
5.3 Electrical Installation

Danger! If the following instructions are not complied with, there is direct danger with the possible consequences of death or severe injury by electrical current. Further, failure to comply can lead to destruction of the frequency inverter and/or of the extension module.

- Before electrical installation of the EM-ABS-01 extension module, the frequency inverter must be de-energized. Take appropriate measures to make sure it is not energized unintentionally.
- Make sure that the frequency inverter is discharged.

Danger! When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Wait for at least three minutes until the DC link capacitors have discharged before starting to work at the unit.

5.3.1 Block diagram



Caution! The digital inputs and the DC 24 V terminal of the electronic control equipment can withstand external voltage up to DC 30 V. Avoid higher voltage levels. Higher voltages may destroy the module.

Ⓐ Voltage input, connection for external power supply of encoder
Input voltage range DC 24 V ±10%, U_{max} = DC 30 V,
Rated input current: max. DC 1.0 A (typical DC 0.45 A),
Peak inrush current: typical: < DC 20 A,
External fuse: standard fuse elements for rated current, characteristic: slow,
Safety: Safety extra low voltage (SELV) according to EN 61800-5-1

Ⓑ Digital outputs EM-S1OUTD, EM-S2OUTD
Digital signal, DC 24 V, I_{max} = 40 mA, PLC compatible, overload and short-circuit proof

Ⓒ Voltage output for encoder supply
DC 5 V … 12 V, according to configuration of parameter *Supply voltage* **1187** (factory setting DC 5.0 V), P_{max} = 2 W

Caution! The power output on terminal X410A.1 may be loaded with a maximum power of 2 W. Higher power levels can damage components of the module.

Ⓓ Analog input EM-S1INA
Analog signal, resolution 13 bit, U_{max}= DC ±10 V (R_i = 100 kΩ)

Ⓔ Digital inputs EM-S1IND ... EM-S3IND
Digital signal, response time 1 ms in configurations x40 ("Positioning"), 4 ms in all other configurations, U_{max}= DC 30 V, 10 mA at DC 24 V,
PLC-compatible,
frequency signal, DC 0 ... 30 V, 10 mA at DC 24 V

Ⓕ Communication interface system bus
CAN-connection of system bus according to ISO-DIS 11898 (CAN High Speed), bus termination can be activated via switch

Ⓖ Inputs for SinCos encoders and PTC (15-pin female connector HD-Sub-D)
The encoder interface is designed for connection of standard commercial SinCos (optionally with commutation tracks for synchronous motors), EnDat 2.1 (SinCoS track required), Hiperface and SSI encoders (optionally with TTL [RS-422] or SinCos track). Depending on the encoder type, different signals are evaluated. The following signals can be evaluated:
- A/B tracks and/or Sin/Cos tracks
- C/D tracks (commutation tracks) or Data/Clock tracks (absolute value encoders)
- R tracks (reference track)
- Measuring line for monitoring and control of encoder supply voltage

Input: sinusoidal incremental signals, internal resistance of source <100 Ω,
A/B and C/D tracks: Direct portion V =DC 2.5 V ±0.5 V, peak value: 0.6 V,
R-track: Direct portion V =DC 2.5 V ±0.5 V, differential voltage: 1.8 V.

The encoder supply voltage at contacts X412.6 (V_{Enc}) and X412.15 (0VL) can be adjusted through parameter *Supply voltage* **1187** in between DC 5.0 … 12 V. See chapter 8.4.4 "Supply voltage". Max. load: 2 W.

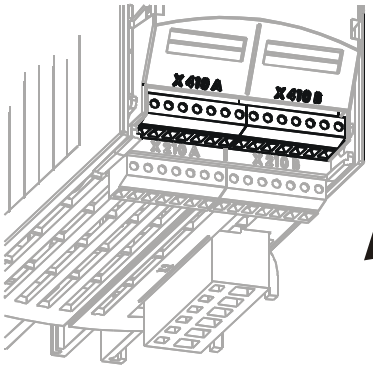
PTC input:
Trigger resistance = 2.4 kΩ (PTC) as per DIN 44081,
PTC or bimetal temperature sensor (NC)

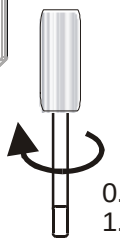
Use PTC resistors with safe isolation from motor winding according to EN 61800-5-1.

5.3.2 Control terminals

The control and software functionality can be configured as required to ensure a reliable and economical operation.

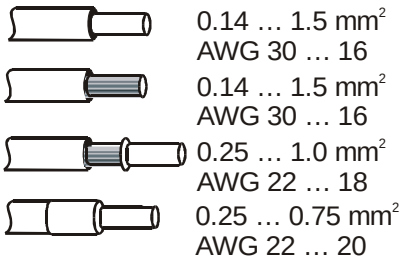
Extension module EM-ABS-01





0.2 … 0.3 Nm
1.8 … 2.7 lb-in

Wieland DST85 / RM3,5



0.14 … 1.5 mm²
AWG 30 … 16

0.14 … 1.5 mm²
AWG 30 … 16

0.25 … 1.0 mm²
AWG 22 … 18

0.25 … 0.75 mm²
AWG 22 … 20

Caution! Switch off power supply before connecting or disconnecting the control inputs and outputs.

Attention! In order to minimize electromagnetic interference and to obtain a good signal quality, the shield of the cable is to be connected to ground on a plane at both ends.

Control terminal X410A

Terminal	Description
1	DC 24 V voltage input
2	Ground (GND) DC 24 V
3	Digital output EM-S1OUTD[1)]
4	Digital output EM-S21OUTD[1)]
5	DC 5 … 12 V voltage output[2)]
6	Analog input EM-S1INA[1)]
7	Ground DC 10 V

Control terminal X410B

Terminal	Description
1	Ground (GND)
2	Digital input EM-S1IND[1)]
3	Digital input EM-S2IND[1)]
4	Digital input EM-S3IND[1)]
5	System bus, CAN low
6	System bus, CAN high
7	Ground (GND)

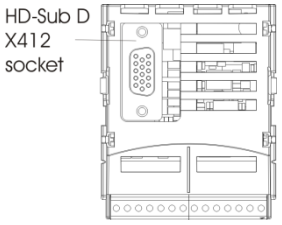
1) The control electronics parameters can be configured as required.

2) The max. power available is reduced by the other used control outputs of the frequency inverter and extension module. For sufficient power, connect an external power source to the DC 24 V voltage input.
The voltage value can be adjusted via parameter *Supply voltage* **1187**.

Caution! The input for external DC 24 V voltage supply can withstand external voltage up to DC 30 V. Avoid higher voltage levels. Higher voltages may destroy the module.

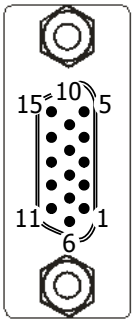
Caution! The power output on terminal X410A.1 may be loaded with a maximum power of 2 W. Higher power levels can damage components of the module.

Female connector X412



Encoder and PTC input X412 (female connector HD-Sub-D)

Contact	Function			
	Sin/Cos	**Hiperface**	**EnDat 2.1**	**SSI**
Housing	PE	PE	PE	PE
1	D-		Clock-	Clock-
2	D+		Clock+	Clock+
3	Cos-	Cos-	B- / Cos-	(optionally B- / Cos-)
4	Cos+	Cos+	B+ / Cos+	(optionally B- / Cos-)
5	TM_{PTC} –	TM_{PTC} –	TM_{PTC} –	TM_{PTC} –
6	V_{Enc}	V_{Enc}	V_{Enc}	V_{Enc}
7	R-			
8	C-	Data-	Data-	Data-
9	Sin-	Sin-	A- / Sin-	(optionally A- / Sin-)
10	TM_{PTC} +	TM_{PTC} +	TM_{PTC} +	TM_{PTC} +
11	$V_{Enc,Sense}$		$V_{Enc,Sense}$	$V_{Enc,Sense}$
12	R+			
13	C+	Data+	Data+	Data+
14	Sin+	Sin+	A+ / Sin+	(optionally A+ / Sin+)
15	GND	GND	GND	GND



Function and signal

Function	Signal
Housing	Shield connected with PE
A+/A- Sin+/Sin- B+/B- Cos+/Cos- C+/C- D+/D-	0.6 V … 1.2 Vss incremental signal In the case of SSI encoders, the A+/A- and B+/B- tracks can be used, as an option, for TTL [RS-422] or SinCos signals.
R+/R-	DC 0.2 … 1.7 V analog signal
Clock+/Clock-	Clock signal
Data+/Data-	Data signal
TM_{PTC} + TM_{PTC} –	Motor PTC
V_{Enc} GND	Encoder supply (DC 5 … 12 V) [1], max. load capacity 2 W
V_{EncS}	Measuring line for monitoring of V_{Enc} [2]

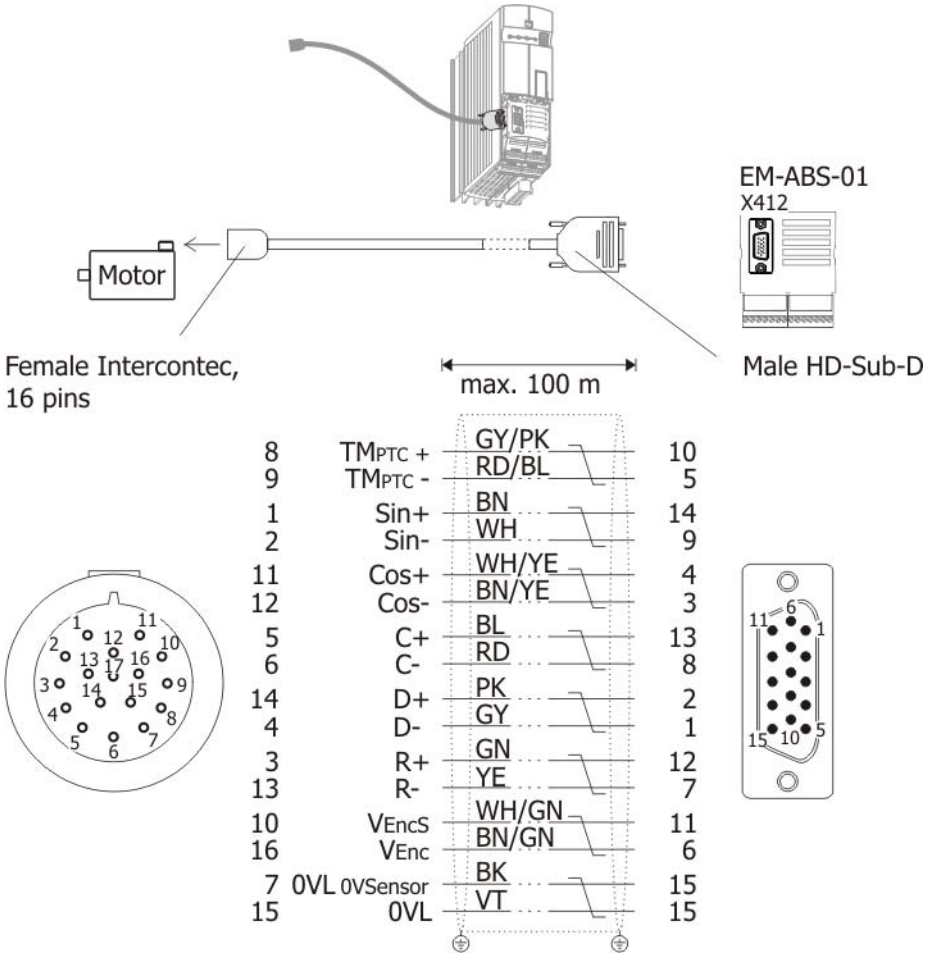
V_{ss}: peak-peak voltage

[1] The voltage value can be adjusted via parameter *Supply voltage* **1187**. See chapter 8.4.4 "Supply voltage".

[2] Voltage control via the measuring line can be activated, as an option, through parameter *Power Supply* **1186**. See chapter 8.4.3 "Power supply".

5.3.2.1 Cable assembly SinCos

Contact assignment BONFIGLIOLI VECTRON assembled cable for connection of SinCos encoders



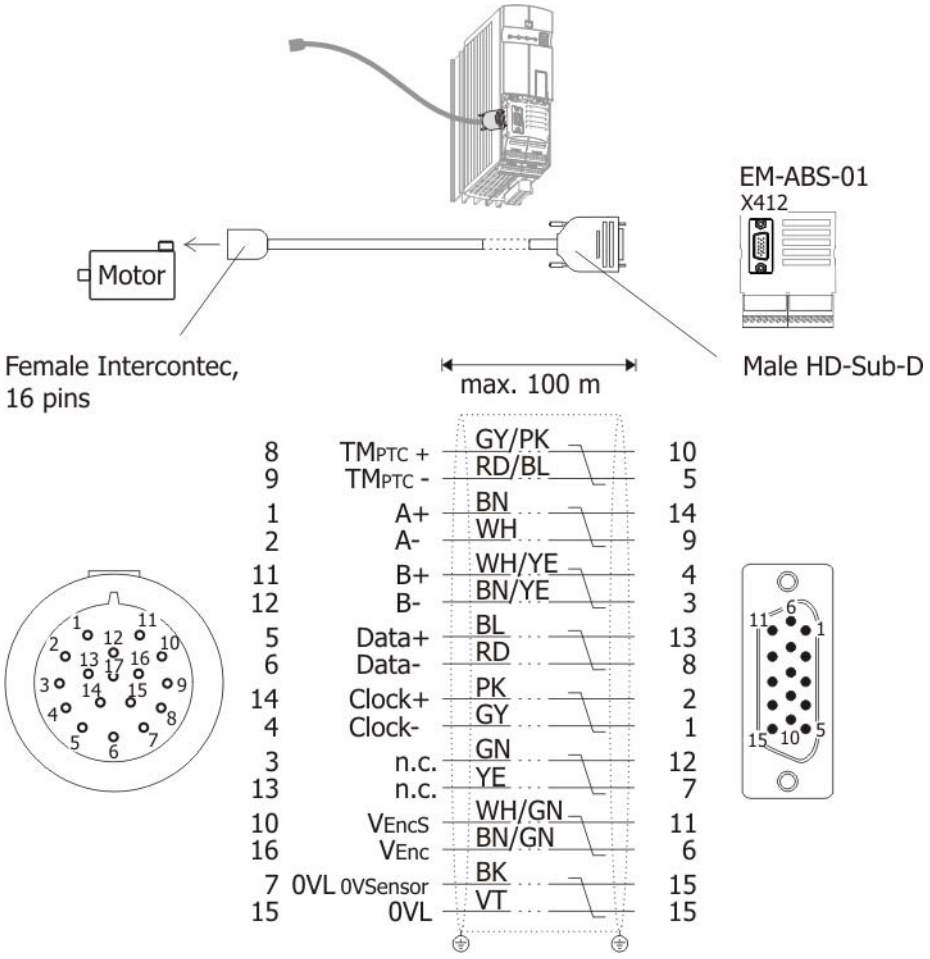
BONFIGLIOLI VECTRON assembled cable	
Encoder cable	8 twisted two-wire lines
Cable size	0.14 mm^2
Length	3 m, 5 m or 10 m

Note: The assembled cables for EnDat 2.1 and SinCos encoders are identical. For better readability of the individual connections, the specific designations for SinCos and EnDat 2.1 are used.

- Use PTC resistors with safe isolation from motor winding according to EN 61800-5-1.
- Use shielded and twisted cables.
- Install encoder cable separate from motor cable.
- Connect the shield of the encoder line properly on both sides.
- BONFIGLIOLI VECTRON recommends using the pre-assembled cables for synchronous motors types BCR and BTD.

5.3.2.2 Cable assembly EnDat 2.1

Contact assignment BONFIGLIOLI VECTRON assembled cable for connection of EnDat 2.1 encoders



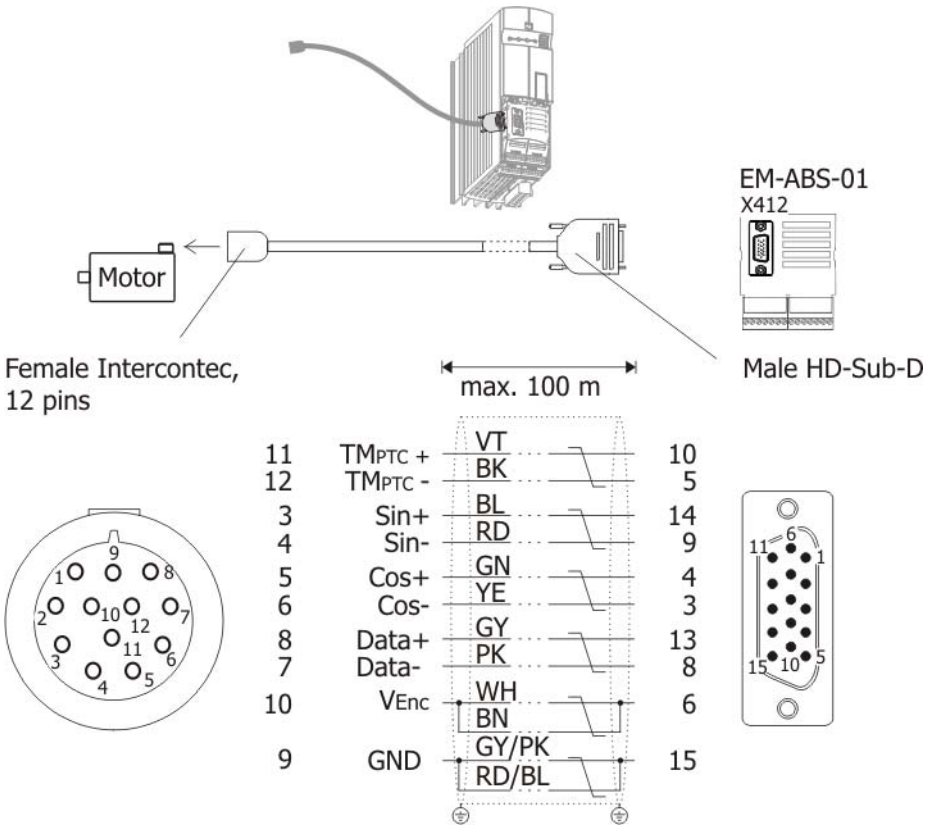
BONFIGLIOLI VECTRON assembled cable	
Encoder cable	8 twisted two-wire lines
Cable size	0.14 mm^2
Length	3 m, 5 m or 10 m

Note: The assembled cables for EnDat 2.1 and SinCos encoders are identical. For better readability of the individual connections, the specific designations for SinCos and EnDat 2.1 are used.

- Use PTC resistors with safe isolation from motor winding according to EN 61800-5-1.
- Use shielded and twisted cables.
- Install encoder cable separate from motor cable.
- Connect the shield of the encoder line properly on both sides.
- BONFIGLIOLI VECTRON recommends using the pre-assembled cables for synchronous motors types BCR and BTD.

5.3.2.3 Cable assembly Hiperface

Contact assignment BONFIGLIOLI VECTRON assembled cable for connection of Hiperface encoders



- Use PTC resistors with safe isolation from motor winding according to EN 61800-5-1.
- Use shielded and twisted cables.
- Install encoder cable separate from motor cable.
- Connect the shield of the encoder line properly on both sides.
- BONFIGLIOLI VECTRON recommends using the pre-assembled cables for synchronous motors types BCR and BTD.

5.3.3 Power supply

Encoder power supply can be effected in different ways. Depending on the consumers connected, there are different encoder power supply possibilities or requirements.

Generally, there are three different application types:

- Low power demand (< 0.5 W) and power supply ≤ 12 V:
  ➔ Internal power supply.
- Medium power demand (0.5... 2 W) and power supply ≤ 12 V:
  ➔ Power supply to be looped via X410.
- High power demand (> 2 W) or power supply > 12 V:
  ➔ Connect encoder directly to external power supply.

Encoders with high power demand (> 2 W) or voltage higher than DC 12 V must be connected to an external power supply directly.

External power supply can be connected via terminals X410A for encoder supply. In this case, a DC 24 V supply can be controlled down, by the EM-ABS-01 module, to the frequently needed voltage levels DC 5…12 V.

5.3.3.1 Internal power supply

Encoders with a low power consumption (< 0.5 W) can be supplied, in most cases, by the internal power supply unit.

Set parameter *Power supply* **1186** to either "1 - internal" or "5- internal, sense". See chapter 8.4.3 "Power supply".
The voltage level can be set up via parameter *Supply voltage* **1187**. See chapter 8.4.4 "Supply voltage".

The encoder can be powered as follows:

- via control terminals X410A.5 (DC 5 … 12 V) and X410A.7 (GND) or
- via contacts X412.6 (VEnc) and X412.15 (GND) of the female HD-Sub-D connector.

See chapter 5.3.2 "Control terminals".

Caution! If power supply is done via the internal power supply of the encoders, a total power of 2 W is available for all consumers connected to digital, analog and encoder interfaces. This includes all interfaces of the ACU basic device and the EM-ABS-01 module together.

5.3.3.2 Looping via terminals X410A

In some cases, encoder power supply must be supported or effected by an external power supply. This is a good idea especially in the case of encoders with medium power demand (0.5…2 W) or when many consumers are connected to the signal terminals.

An external DC 24 V power supply can be connected to terminals X410A.1 (DC 24 V) and X410A.2 (ground). Via this power supply, a connected encoder can be powered. BONFIGLIOLI VECTRON recommends connecting an external power supply.

Requirements to be met by external power supply	
Input voltage range	DC 24 V ±10%
Rated input current	Max. DC 1.0 A (typical DC 0.45 A),
Peak inrush current	Typically: < DC 20 A
External fuse	Standard fuse elements for rated current, characteristic: slow
Safety	Safety extra low voltage (SELV) according to EN 61800-5-1

Note: Connect the power supply for the encoder to terminals X410A.1 and X410A.2. Connection via the terminals of the basic device ACU (X210A.1 and X210A.2) is not sufficient for powering the EM-ABS-01 module and the encoder.

Caution! If the encoder is powered via X410A, 2 W power are available to the encoder interface. Another 2 W are available to the interfaces (digital/analog inputs/outputs) of the basic device.

Caution! The inputs for the external power supply can withstand external voltage up to DC 30 V. Avoid higher voltage levels. Higher voltages may destroy the module.

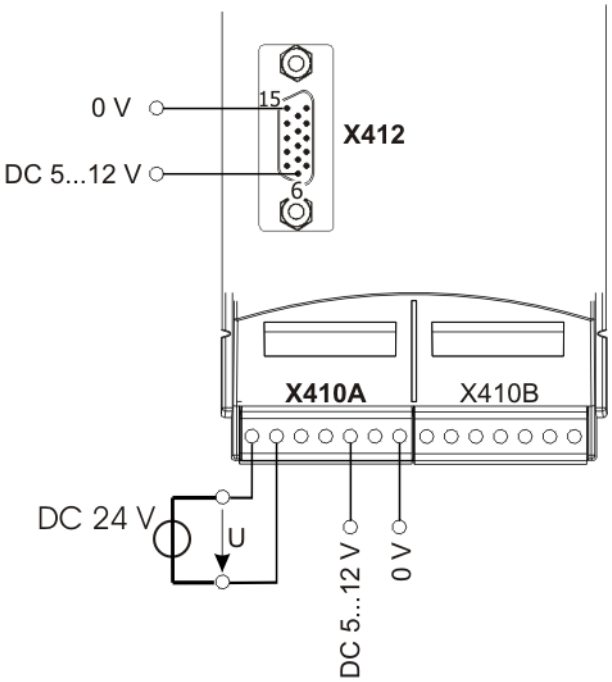
Caution! Some encoders (e.g. laser distance meters) need more power than possible with the power supply described here. If the encoder requires a power level higher than 2 W or more than DC 12 V, it must be connected to an external power supply directly. Non-fulfillment of this requirement may result in dangerous plant states.

Set parameter *Power supply* **1186** to either "2 - via X410A" or "6 via X410A, sense". See chapter 8.4.3 "Power supply".
The voltage level can be set up via parameter *Supply voltage* **1187**. See chapter 8.4.4 "Supply voltage".

The encoder can be powered as follows:
- via control terminals X410A.5 (DC 5 … 12 V) and X410A.7 (GND) or
- via contacts X412.6 (V_{Enc}) and X412.15 (GND) of the female HD-Sub-D connector.

See chapter 5.3.2 "Control terminals".

Voltage input and voltage outputs for encoder power supply



Terminal X410A.1: DC 24 V input
Terminal X410A.2: DC 24 V ground
Terminal X410A.5 and X412.6: DC 5…12 V output
Terminal X410A.5 and X412.15: DC 5…12 V ground
Connect a maximum load of 2 W !

5.3.3.3 Direct connection of external power supply to the encoder

Encoders with high power demand (> 2 W) or voltage higher than DC 12 V must be connected to an external power supply directly.

Set parameter *Power supply* **1186** to "1-internal". See chapter 8.4.3 "Power supply". This setting must be used for proper function of the evaluation. However the power supply terminals do not have to be connected but should remain open.
The voltage level set in *Supply voltage* **1187** is irrelevant when the terminal is open. See chapter 8.4.4 "Supply voltage".

Note: In this case, do not set *Power supply* **1186** to modes with "sense" line. This will result in faults and system shutdown

6 Commissioning the encoder

This chapter describes how the different encoder types are commissioned.

6.1 General Information

The EM-ABS-01 supports both Singleturn and Multiturn encoders. Multiturn encoders must be configured as such in order to avoid unwanted effects.

The internal resolution of encoder information is 32 bits, 16 bits for the position in one turn and 16 bits for the number of turns. Encoders with other properties will be converted to this format internally.

Note: In the case of motor encoders with a multiturn portion of more than 16 bits, clear identification of the position in the frequency inverter is not guaranteed.

Note: In the case of motor encoders with a multiturn portion of less than 16 bits, the free bits are filled up to 16 bits and managed in a fail-safe manner.
Example: An encoder has a multiturn portion of 13 bits. 3 bits are managed additionally in the inverter, thus 8 (=2^3) overflows of the multiturn portion are recognized.

This information may be lost in some situations if the DC link is discharged very quickly due to external conditions.

In the case of usage in positioning applications (configuration x40), the absolute position of the encoder can be used for the reference system directly in user units [u]. Using gear factors, a gear transmission between the encoder and the travel distance can be considered.

Note: The input data of the encoder is evaluated via the reference systems. The evaluated parameters (e.g. motor frequency, drive speed in rev/s, position in rev.) are available for diagnosis via actual value parameters, see chapter 8.6 “Actual value display”.

Check the power demand of the encoder to be connected. The internal power supply unit can only supply a maximum total of 2 W for all consumers connected. In the case of a higher power demand, connect an external DC 24 V supply to X410A.1 (DC 24 V voltage input) and X410A.2 (GND). BONFIGLIOLI VECTRON recommends connecting an external power supply. Refer to chapter 5.3.3 “Power supply”.

Note: For supply of the encoder via an external power supply unit, always connect it to X410A.1 (DC 24 V voltage input) and X410A.2 (GND). Connection at X210A.1 (DC 24 V voltage input of ACU basic device) and X210A.2 (GND) will not be sufficient for external power supply of the encoder.

Install encoder cables separate from motor cables to minimize interference.

Upon first commissioning and during operation, make sure that the encoder and other electrical components can acclimatize in order to prevent condensation and resulting malfunction.

6.1.1 Information on use

After mains on, an initialization may have to be performed depending on the encoder type. This may take up to 5 seconds, depending on the encoder type. This time can be eliminated by powering the basic device and the encoder using an external DC 24 V supply.

When the encoder or motor (including motor encoder) are replaced, re-calibration will typically be required for the absolute position. This applies typically to the encoder-internal value (depending on the encoder type used, this value cannot be changed), position angle *Offset* **1188** and, in positioning applications (configuration x40), referencing *Home-Offset* **1131**. After encoder replacement, always check the position angle *Offset* **1188** and carry out a referencing operation in the case of positioning applications (configuration x40).

Note: When an absolute value encoder is used, referencing is not required after encoder or motor replacement to ensure **correct function of the ACU device**. Adjustments of *Home-Offset* **1131** are applied directly.
After encoder or motor replacement, **correct function of the system** is achieved by performing a referencing operation or offset adjustment.

The signals provided by the encoder are used in the EM-ABS-01 for various plausibility checks. This makes the system more fail-safe and less prone to unwanted interference.

During operation, the encoders and communication with the encoder are monitored. Critical conditions are reported via device errors. Most error evaluations will only be performed when the power output stage is activated.

Danger! Some absolute value encoder types enable to "zero" or change the position transmitted by the encoder. Do not use this function, as this will change the commutation angle in synchronous motors for *Offset* **1188** and correct speed control is not guaranteed.
Changing the value while the system is in operation can result in significant failures of the system.

Attention! Via parameter *Change Sense of Rotation* **1199**, you can change the direction of rotation of the motor system. In the case of absolute value encoders, a change of *Change Sense of Rotation* **1199** will result in an actual value jump. Upon the time of changeover, slave drives in an electronic gear must be switched off.

6.2 SinCos encoders

This chapter describes how SinCos encoders are commissioned.

Note: If a SinCos encoder is used as a motor encoder on a synchronous servomotor, the SinCos encoder must also feature, in addition to signal tracks A/B, commutation tracks C/D (e.g. Heidenhain ERN 1185).

Step 1: Install the EM-ABS-01 as described in chapter 5.2. Do not connect the encoder cable yet.
Step 2: Turn the frequency inverter on for parameter configuration (mains voltage or DC 24 V).
Step 3: Configure the frequency inverter according to the following parameters.

- Adjust the *Division marks* **1183** according to the encoder data sheet (see Chapter 8.4.1), in the case of SinCos encoders, the value is typically 1024 pulses/turn.
- Set *Tracks/Protocol* **1184** to value 100, 300, 500 or 700 (please see chapter 8.4.2).
- Adjust the *Supply voltage* **1187** according to the encoder data sheet (see Chapter 8.4.4), in the case of SinCos encoders, the value is typically 5.0V.
- Adjust *Power supply* **1186** according to the connections (see chapter 8.4.3). Bonfiglioli Vectron recommends evaluating the sense line (settings: "5-intern, Sense" or "6-Via X410A, Sense"), if available and connected.
  Attention: Always set the *Supply voltage* **1187** first and then set *Power supply* **1186**.
- If the encoder is used as a motor encoder for a synchronous servomotor, set *Offset* **1188** according to chapter 8.4.6. This step is not required in the case of asynchronous motors or if the encoder is used as an application encoder.

Step 4: Turn the frequency inverter off.
Step 5: Connect the SinCos Geber to the EM-ABS-01. Bonfiglioli Vectron recommends the use of pre-assembled cables (see chapter 5.3.2.1).
Step 6: Turn the frequency inverter on.
Step 7: Check the encoder for proper function.

Note: SinCos encoders are no absolute value encoders. In configurations "Positioning" x40 you will have to carry out a referencing operation with SinCos encoders after mains on.

6.3 Hiperface encoders

This chapter describes how Hiperface encoders are commissioned.

Step 1: Install the EM-ABS-01 as described in chapter 5.2. Do not connect the encoder cable yet.
Step 2: Turn the frequency inverter on for parameter configuration (mains voltage or DC 24 V).
Step 3: Configure the frequency inverter according to the following parameters.

- Adjust the *Division marks* **1183** according to the encoder data sheet (see Chapter 8.4.1), in the case of Hiperface encoders, the value is typically 1024 amplitudes/turn (in example SRS50/SRM50).

- Set *Tracks/Protocol* **1184** according to the encoder data sheet to value 3109, 3119, 3138 or 700 (please see chapter 8.4.2).
  Typical values:
  Sick SEK37/SEL37 & SEK52/SEL52: 9.6 kBaud → value 3109
  Sick SKS36/SKM36: 9.6 kBaud → = value 3109
  Sick SRS50/SRM50: 9.6 kBaud → = value 3109

- Adjust the *Supply voltage* **1187** according to the encoder data sheet (see Chapter 8.4.4), in the case of Hiperface encoders, the value is typically 8.0 V.

- Adjust *Power supply* **1186** according to the connections to "1-internal" or "2-Via X410A" (see chapter 8.4.3).
  In the case of Hiperface encoders, the sense line (settings "5-intern, Sense" or "6-Via X410A, Sense") is typically not used, as it is not defined in the Hiperface standard Specification. Thus, using the sense line is not required in the case of Hiperface encoders.
  Attention: Always set the *Supply voltage* **1187** first and then set *Power supply* **1186**.

- Set the number of *Bits/Turn* **1271** according to the encoder data sheet (see chapter 8.4.7).
  Typical values:
  Sick SEK37/SEL37 & SEK52/SEL52: 9 bits/t
  Sick SKS36/SKM36: 12 bits/t
  Sick SRS50/SRM50: 15 bits/t

- Set the *Bits Multiturn* **1272** according to the encoder data sheet (see chapter 8.4.8),
  Typical values:
  Sick SEL37, SEL52, SKM36, SRM50: 12 bits/t

Note: In the case of singleturn encoders (e.g. Sick SEK37, SKS36, SRS50), you will have to set *Bits Multiturn* **1272** = 0.

- If the encoder is used as a motor encoder for a synchronous servomotor, set *Offset* **1188** according to chapter 8.4.6. This step is not required in the case of asynchronous motors or if the encoder is used as an application encoder.

Step 4: Turn the frequency inverter off.
Step 5: Connect the Hiperface Geber to the EM-ABS-01. Bonfiglioli Vectron recommends the use of pre-assembled cables (see chapter 5.3.2.3).
Step 6: Turn the frequency inverter on.
Step 7: Check the encoder for proper function.
Step 8: In configurations "Positioning" x40: Carry out referencing operation once.

Note: If the data track cannot be evaluated, error "F1719 Dig. encoder: Protocol error" will be triggered. In this case, check *Tracks/Protocol* **1184** setting.

Note: When the frequency inverter is turned on, the absolute position is read via the data tracks. Via the incremental tracks, the position is counted up internally and compared to the updated absolute position at regular intervals. This guarantees a very high positioning and speed accuracy at all supported transmission rates.

6.4 EnDat 2.1 encoders

This chapter describes how EnDat 2.1 encoders are commissioned.

Note: Only EnDat 2.1 encoders with SinCos tracks can be connected.

Note: The EM-ABS-01 module supports, in the case of EnDat 2.1 encoders, a baud rate of 100 kBit/s. Other baud rates will not be supported.

Step 1: Install the EM-ABS-01 as described in chapter 5.2. Do not connect the encoder cable yet.
Step 2: Turn the frequency inverter on for parameter configuration (mains voltage or DC 24 V).
Step 3: Configure the frequency inverter according to the following parameters.

- Adjust the *Division marks* **1183** according to the encoder data sheet (see Chapter 8.4.1), in the case of EnDat 2.1 encoders, the value is typically 512 amplitudes/turn, (e.g. Heidenhain ECN 1113, EQN 1125).

- Set *Tracks/Protocol* **1184** to value 1101 (please see chapter 8.4.2).

- Adjust the *Supply voltage* **1187** according to the encoder data sheet (see Chapter 8.4.4), in the case of EnDat 2.1 encoders, the value is typically 5.0V.

- Adjust *Power supply* **1186** according to the connections (see chapter 8.4.3). Bonfiglioli Vectron recommends evaluating the sense line (settings: "5-intern, Sense" or "6-Via X410A, Sense").
  Attention: Always set the *Supply voltage* **1187** first and then set *Power supply* **1186**.

- If the encoder is used as a motor encoder for a synchronous servomotor, set *Offset* **1188** according to chapter 8.4.6. This step is not required in the case of asynchronous motors or if the encoder is used as an application encoder.

Note: Parameters *Bits/Turn* **1271** and *Bits Multiturn* **1272** have no function in the case of EnDat 2.1 encoders. The required data is exchanged directly between the encoder and inverter.

Step 4: Turn the frequency inverter off.
Step 5: Connect the EnDat 2.1 Geber to the EM-ABS-01. Bonfiglioli Vectron recommends the use of pre-assembled cables (see chapter 5.3.2.1).
Step 6: Turn the frequency inverter on.
Step 7: Check the encoder for proper function.
Step 8: In configurations "Positioning" x40: Carry out referencing operation once.

Note: If the data track cannot be evaluated, error "F1719 Dig. encoder: Protocol error" will be triggered. In this case, check *Tracks/Protocol* **1184** setting.

Note: When the frequency inverter is turned on, the absolute position is read via the data tracks. Via the incremental tracks, the position is counted up internally and compared to the updated absolute position at regular intervals. This guarantees a very high positioning and speed accuracy at all supported transmission rates.

6.5 SSI encoders

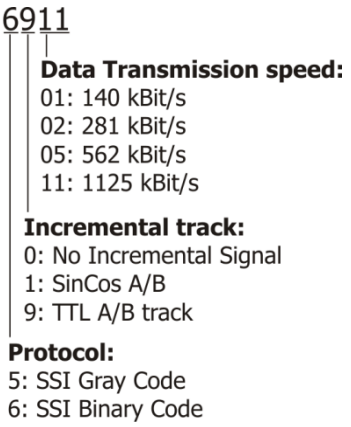
This chapter describes how SSI encoders are commissioned. You can connect SSI encoders with binary evaluation and SSI encoders with Gray code evaluation. **This function is being prepared and is currently not supported!**

Note: For a correct function of the speed control, an SSI encoder with incremental tracks (TTL [RS-422] level or SinCos tracks) must be used.
If the SSI encoder is used for positioning (and not for speed feedback), you can also use a SSI encoder without incremental tracks.
HTL tracks cannot be used as incremental tracks.

Step 1: Install the EM-ABS-01 as described in chapter 5.2. Do not connect the encoder cable yet.
Step 2: Turn the frequency inverter on for parameter configuration (mains voltage or DC 24 V).
Step 3: Configure the frequency inverter according to the following parameters.

- Set *Tracks/Protocol* **1184** according to the encoder data sheet (please see chapter 8.4.2).

SSI operation modes key:



Note: If a SSI encoder without incremental track (*Tracks/Protocol* **1184** = 50xx or 60xx) is used for positioning, the speed of the data track must be as high as possible for optimum control quality.
The usable transmission rate depends on the length of the encoder cable.

- Adjust the *Division marks* **1183** according to the encoder data sheet (see Chapter 8.4.1), in the case of SSI encoders, the value is typically 512 amplitudes/turn. If an encoder without incremental tracks is used (setting via *Tracks/Protocol* **1184**), this information is not needed and the setting of this parameter will be ignored.

- Adjust the *Supply voltage* **1187** according to the encoder data sheet (see Chapter 8.4.4), in the case of SSI encoders with TTL [RS-422] or SinCos track, the value is typically 5.0V.

- Adjust *Power supply* **1186** according to the connections (see chapter 8.4.3). Bonfiglioli Vectron recommends evaluating the sense line (settings: "5-intern, Sense" or "6-Via X410A, Sense"), if available and connected.

- Set the number of *Bits/Turn* **1271** according to the encoder data sheet (see chapter 8.4.7).

- Set the *Bits Multiturn* **1272** according to the encoder data sheet (see chapter 8.4.8).

- Set *SSI: Error-/Extra-Bits (Low)* **1269** and *SSI: Error-/Extra-Bits (High)* **1270** , if additional information from the encoder is supported (see chapter 8.4.9).

- Adjust *SSI: Sample time***1268** according to the encoder data (see chapter 8.4.10).

- If the encoder is used as a motor encoder for a synchronous servomotor, set *Offset* **1188** according to chapter 8.4.6. This step is not required in the case of asynchronous motors or if the encoder is used as an application encoder.

Note: In the case of singleturn encoders, you will have to set *Bits Multiturn* **1272** = 0.

Step 4: Turn the frequency inverter off.
Step 5: Connect the SSI Geber to the EM-ABS-01.
Step 6: Turn the frequency inverter on.
Step 7: Check the encoder for proper function.
Step 8: In configurations "Positioning" x40: Carry out referencing operation once.

Note: If the data track cannot be evaluated, error F1719 Dig. encoder: Protocol error" will be triggered. In this case, check *Tracks/Protocol* **1184** setting.

Note: When the frequency inverter is turned on, the absolute position is read via the data tracks. Via the incremental tracks, the position is counted up internally and compared to the updated absolute position at regular intervals. This guarantees a very high positioning and speed accuracy at all supported transmission rates.
Encoders without incremental track can only be used as application encoders (for example for positioning applications).

6.6 Commissioning of linear encoders

In addition to the settings described in the previous chapters, the conversion from the rotary to the translatory system must be considered when it comes to commissioning a linear encoder. This conversion is influenced greatly by the diameter of the turning wheel.

The following applies:
Circumference = π * diameter

Note: Linear encoders are normally not suitable for speed control, as the sampling time is too long to enable good speed control. For this reason, the following descriptions are based on the use as a position encoder in configuration x40.

Note: For the calculations described in this chapter, an Excel worksheet was prepared by Bonfiglioli. Please contact your local sales agent. This Excel worksheet will help you to carry out the calculations required for commissioning linear encoders with ACTIVE CUBE frequency inverters.

Linear encoders typically have a fixed resolution (e.g. 1 mm). In some linear encoders, the resolution can be configured. First check the resolution of the linear encoder using the data sheet or the parameter configuration.

The resolution of the linear encoder must be assigned in the frequency at the resolution of the selected user units. This is done using the four parameters *Bits/Turn* **1271**, *Bits Multiturn* **1272**, *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514**.

The positioning reference system is always referred to the output side, in user units, through parameters *Feed constant* **1115**, *Gear Box: Driving Shaft Revolutions* **1116** and *Gear Box: Motor Shaft Revolutions* **1117**. Thus, these parameters must also be considered when configuring the linear encoder.

Note: Parameters *Bits/Turn* **1271** and *Bits Multiturn* **1272** are virtual quantities in the case of a linear encoder and are determined by the mechanical properties of the system. Different properties of the mechanical system (e.g. gear transmission or turning wheel diameter) will lead to different parameter settings.

Note: Shifting of a bit in parameters *Bits/Turn* **1271** and *Bits Multiturn* **1272** has the same effect as doubling or halving in parameters *EC2 Gear Factor Numerator* **513**/ *EC2 Gear Factor Denominator* **514**.
Reduction of *Bits/Turn* **1271** or increase of *Bits Multiturn* **1272** by 1 Bit
--> has the same effect as doubling of **513** / **514**
Increase of *Bits/Turn* **1271** or reduction of *Bits Multiturn* **1272** by 1 Bit
--> has the same effect as halving of **513** / **514**

Required data:
The following data is needed for commissioning of the linear encoder:

Gear transmission [] or input speed / output speed [rpm/rpm]
Encoder resolution [bits]
Running wheel diameter [m]
Required accuracy [m] or resolution [increments/m]

1st step: Identify gear values reference system:
The input speed (motor speed) will determine the setting for parameter *Gear Box: Motor Shaft Revolutions* **1117**, the output speed will determine the setting for parameter *Gear Box: Driving Shaft Revolutions* **1116**.
The value should be entered as exactly as possible. Shifting of decimal places or multiplication with appropriate factors can increase accuracy.

Example:
Input speed: 1401 rpm
Output speed: 77.3 rpm i = 18.12
Encoder resolution: 24 Bit
Diameter: 160 mm = 0.16 m
Required accuracy: 0.01 mm = 0.00001 m

- ➔ *Gear Box: Motor Shaft Revolutions* **1117 =** 14010
- ➔ *Gear Box: Driving Shaft Revolutions* **1116 =** 773

2nd step: Identify feed constant reference system:
The feed constant is calculated by multiplying the diameter and π by the resolution. The resolution is the reciprocal of the accuracy.

$$\text{Accuracy [m]} = \frac{1}{\text{Resolution}\left[\frac{\text{u}}{\text{m}}\right]}$$

$$\textit{Feed constant } \mathbf{1115}\,[\text{u}] = \frac{\pi \cdot \text{Diameter [m]}}{\text{Accuracy}[\frac{\text{m}}{\text{u}}]}$$

$$= \pi \cdot \text{Diameter [m]} \cdot \text{Resolution}\left[\frac{\text{u}}{m}\right]$$

Example:
Diameter: 0.16 m = 160 mm
Required resolution: 0.00001 m = 0.01 mm

- ➔ *Feed constant* **1115 =** 50265 rev

3rd step: Calculate auxiliary quantity reference system
In the following step, the ratio of the *Feed constant* **1115** to *Gear Box: Driving Shaft Revolutions* **1116** and *Gear Box: Motor Shaft Revolutions* **1117** is used in the calculations frequently. For better clarity, auxiliary quantity "R" (=reference system) is calculated now:

$$\text{R} = \frac{\textit{Feed constant } \mathbf{1115}\,\frac{[\text{u}]}{\text{U}} \cdot \textit{GearBox}:\textit{DrivingShaftRevolutions } \mathbf{1116}}{\textit{GearBox}:\textit{MotorShaftRevolutions } \mathbf{1117}}$$

Example:
Feed constant **1115 =** 50265 rev
Gear Box: Driving Shaft Revolutions **1116 =** 773
Gear Box: Motor Shaft Revolutions **1117 =** 14010

- ➔ R = 2773.365 rev = 50265 x 773 / 14010 rev

4th step: Determine the encoder resolution:
First determine the number of user units per encoder increment. If, for example, the encoder features a resolution of 1 mm and 0.01 is to be used as the "user unit", β = 100.

β = Number of user units per encoder increment

5th step: Calculate *Bits/Turn* **1271** :
The reference system and the number of user units per encoder increment β determine parameter *Bits/Turn* **1271**.

$$Bits / Revolution = \mathrm{Log}_2 \frac{Feed\ Constant\ \mathbf{1115}\ \frac{[u]}{U} \cdot GearBox : DrivingShaftRevolutions\ \mathbf{1116}}{\beta \cdot GearBox : MotorShaftRevolutions\ \mathbf{1117} \cdot}$$

or

$$Bits / Revolution = \mathrm{Log}_2 \frac{R}{\beta}$$

$$= \frac{1}{\mathrm{Ln}\ 2} \cdot \mathrm{Ln} \frac{R}{\beta}$$

Round the value up to the next natural number.

With the values above, *Bits/Turn* **1271**=5.

Note: Conversion of logarithm base 2 and other bases:

$$\mathrm{Log}_2 a = \frac{\mathrm{Log}_{10} a}{\mathrm{Log}_{10} 2} = \frac{\mathrm{Ln}\ a}{\mathrm{Ln}\ 2}$$

6th step: Calculate *Bits Multiturn* **1272** :
Bits Multiturn **1272** is calculated from the subtraction of the total number of position bits of the encoder with the *Bits/Turn* **1271** calculated above.

$$Multiturn = GeberBits - Bits / Umdrehung$$

With the values above, *Bits Multiturn* **1272**=19.

7th step: Calculation of speed sensor 2 gear factors
For calculation of speed sensor 2 gear factors, the *preliminary numerator* is calculated first as follows:

Preliminary Numerator **= 2 ^** *Bits/Turn* **1271**

Then, the preliminary denominator is calculated:

$$PreliminaryDenominator = \frac{Feed\ Constant\ \mathbf{1115}\ \frac{[u]}{U} \cdot GearBox : DrivingShaftRevolutions\ \mathbf{1116}}{\beta \cdot GearBox : MotorShaftRevolutions\ \mathbf{1117} \cdot}$$

or

$$PreliminaryDenominator = \frac{R}{\beta}$$

With the example values, the following results are obtained:
Preliminary Numerator = 32.
Preliminary Denominator = 27.7336.

The values calculated in this way can be used directly for parameters *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514**. To increase accuracy, the following intermediate "Optimization" step is recommended. This intermediate step is not necessary if accuracy is already sufficient.

EC2 Gear Factor Numerator **513** = 32.00.
EC2 Gear Factor Denominator **514** = 27.73

8the step: Optional: Optimization of gear factors
The steps carried out above will result (provided that calculation was made correctly) in a denominator which is smaller than the numerator. This advantage is used for optimization.

The following is set:

EC2 Gear Factor Numerator **513** = 300.00.

Value 300.00 is always used to achieve maximum accuracy.

$$ConclusiveDenominator = 300{,}00 \cdot \frac{PreliminaryDenominator}{PreliminaryNumerator}$$

With the example values, the following results are obtained:
EC2 Gear Factor Numerator **513** = 300.00.
EC2 Gear Factor Denominator **514** = 260.00

Note: Parameter *EC2 Gear Factor Numerator* **513** is limited to value range -300.00...300.00. To maximize the value range of the factors, the maximum value 300.00 is used for optimization.

9th step: Optional: Check of accuracy:
This section describes the calculations required for determining the accuracy. The check is not required for proper function, it is solely for determining the accuracy limits.
Due to rounding operations in the parameters described above, there will be an error across the total travel distance. This error is calculated in the following steps:

$$(1)\ Distance\_ref[u] = \frac{Distance\_ref[m]}{Accuracy\left[\frac{m}{u}\right]}$$

$$(2)\ Distance\_act[internal] = \text{RoundDown}\left(\frac{EC2GearFactorNumerator\ \mathbf{513}}{EC2GearFactorDenominator\ \mathbf{514}} \cdot \frac{Distance\_ref[u]}{ß} \cdot \frac{2^{16}}{2^{Bits/Revolution}\ \mathbf{1271}}\right)$$

$$(3)\ Distance\_act[u] = \text{RoundDown}\left(Distance\_act[\text{intern}] \cdot \frac{R}{2^{16}}\right)$$

(4) $Error[u] = Distance\_act[u] - Distance\_ref[u]$

(5) $Error[m] = Distance\_act[u] \cdot Accuracy\left[\frac{m}{u}\right] - Distance\_ref[m]$

The error can be reduced by increasing the accuracy of the gear factors. By using the 2 decimal places of parameters *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514** and the optimization described in the previous step ("8 Optimization of gear factors"), accuracy can be increased.

At a maximum travel distance of 10 m, the following is obtained:

Non-optimized gear factors	Optimized gear factors
Distance_nominal [rev] = 1 000 000 rev	Distance_nominal [rev] = 1 000 000 rev
Distance_actual [internal] = 23 633 609	Distance_actual [internal] = 23 630 769
Distance_actual [rev] = 1 000 131 rev	Distance_actual [rev] = 1 000 011 rev
Error [rev] = 131 rev	Error [rev] = 11 rev
Error [m] = 0.00131 m	Error [m] = 0.00011 m
Error [mm] = 1.3 mm	Error [mm] = 0.11 mm

Note: Parameter *EC2 Gear Factor Numerator* **513** is limited in value range -300.00...300.00, *EC2 Gear Factor Denominator* **514** is limited in value range 0.01 to 300.00. In many situations, choosing a modifier is useful which sets the greater of the two parameters to a value slightly below 300.00.

6.6.1 Checking the settings

Upon completion of the setup, check the system for proper function.

Danger! Wrong setup of the linear encoder can result in incorrect movements or direction of movement.
The following requirements must be met when it comes to testing the linear encoder:

- Before the start of the test, make sure the hardware limit switches work properly.
- Before the start of the test, make sure the emergency stop works properly.
- Use
  - slow speeds
  - slow ramps
  - Deactivate the position controller by setting 1118 = 0.

Note: To reduce the speeds, you can use the so-called "Speed Override" mode.

Via actual value parameter *Abs. encoder raw data* **1267**, you can monitor the encoder value transmitted. Carry out a travel operation across a distance which can be measured easily (e.g. 10 cm). Check if the actual value parameter *Abs. encoder raw data* **1267** changes and the *Act. Position* **1108** changes across the distance in accordance with your settings.

Via the scope function of VPlus, you can check the commissioning of the linear encoder.
Adjust the following scope sources:
1003 Act. Position * 1000
1007 Ref. Position * 1000
1013 Contouring Error *10 or 1012 Contouring Error *1
442 Hz: Act. Speed

As the time base, choose the observation period for some seconds.

When starting a motion block or a travel command via field bus, Ref. Position is set to Act. Position. The two curves of sources 1003 and 1007 must be identical as from the start time of the travel command. If the two curves are not identical, the parameter factors have not been set correctly.
If the ramp Act. Position is steeper than the ramp of Ref. Position, the ratio 513/514 must be reduced.
If the ramp Act. Position is less steep than the ramp of Ref. Position, the ratio 513/514 must be increased.

Via the source of the contouring error, the quality of the settings can be checked additionally. The contouring error must not increase continuously. Due to the mechanical characteristics, a small constant contouring error is typical to the system, continuous (significant) increasing of the contouring error (also in negative direction) indicates that linear encoder parameters have be set up incorrectly.

Note: When the position controlled is deactivated, rounding errors may result in a minor continuous increase in the contouring error. In most cases however, this is small enough to be distinguishable.

As soon as the settings have been checked for correctness, repeat the tests using sources 1002/ 1006 (resolution 10 times higher than sources 1007/1011), then using 1001 / 1005 and then using 1000 and 1004. In this way, the settings are checked again at a higher accuracy. Note that, with a higher accuracy, overflows may be displayed in Scope more frequently. This does not affect the function.

Note: Depending on the reference system chosen (Parameter *Feed constant* **1115**, *Gear Box: Driving Shaft Revolutions* **1116** and *Gear Box: Motor Shaft Revolutions* **1117**), some sources may not have the required significance in Scope. Then, switch to the next smaller couple as shown above. Always start with the highest setting.

Activate the position controller again. Position controller *Limitation* **1118** settings must always match the reference system and the mechanical system.
A contouring error will typically build up during acceleration or deceleration. During constant travel operations, the contouring error should become smaller again. Note that the *Maximum frequency* **419** is exceeded by the output of the position controller. Ensure that the total of *Maximum frequency* **419** and position controller *Limitation* **1118** can be reached by the mechanical equipment. A reduction of the maximum frequency may be a good idea in certain applications in order to limit the total to the mechanically possible maximum.
In most application, limitation of position controller *Limitation* **1118** to approx. 10 % of the maximum frequency makes sense.

With the position controller activated, check the function again.

6.6.2 Initialize counting direction

First check if the counting direction of the user units meets the requirements. You can change the counting direction by inverting the parameter *EC2 Gear Factor Numerator* **513** (e.g. by inverting parameter *EC2 Gear Factor Numerator* **513** from 200.00 to -200.00).

Danger! By changing parameter *EC2 Gear Factor Numerator* **513**, the encoder values will be re-calculated in the internal user unit format. As a result, the value of *Act. Position* **1108** may change. Especially when software limit switches are used or in the case of feedback to a PLC, this can result in warnings or application errors. For this reasons, after changing the parameters of the reference system and the encoder, always check the *Act. Position* **1108**, considering the permissible travel distance (e.g. *Pos. SW Limit Switch* **1145**).

6.6.3 Initializing home position

For positioning application, a certain point of the system is typically defined as the home position. After checking the correct reference system of the positioning and linear encoder (see Chapter 6.6.1) and setting the counting direction, the home position can be initialized.
Move (e.g. in JOG mode) to the required system home position. At this position, stop the drive. Set parameter *Home Offset* **1131** = 0.

Note: By default, *Home Offset* **1131** is set to zero. Upon first commissioning, you do not have to change the value, but this step is required in the case of commissioning following a change.

Now, read the value in parameter *Act. Position* **1108**. Invert this value. Enter the inverted value in *Home Offset* **1131**.

Example:
Act. Position **1108** = 7654 u → *Home Offset* **1131** = - 7654

Once you have set up the home position offset, check the system for correct function again (see chapter 6.6.1).
If required for the application, set up the software limit switches now.

Note: Referencing using an absolute value encoder is not necessary after completion of first commissioning. The referencing setting *Operation mode* **1220** with setting "10 – No referencing required" can be used after initialization.

7 System bus interface

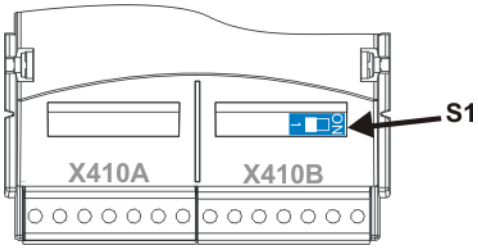
The CAN connection of the system bus is physically designed according to **ISO-DIS 11898** (CAN High Speed). The bus topology is the line structure.

In the default version, the ACU series of frequency inverters supports a CAN protocol controller. This controller can be used in the CM-CAN communication module with CANopen interface as well as in an extension module for the system bus, such as the EM-ABS-01 extension module.

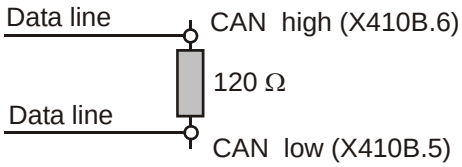
7.1 Bus termination

The bus necessary on the phase in the physically first and last subscriber can be activated via the DIP switches on the EM-ABS-01 extension module.

- Set to **ON** (right position) for passive termination.



Attention! By default, the bus termination is set to "1" (OFF, switch in left position).



passive

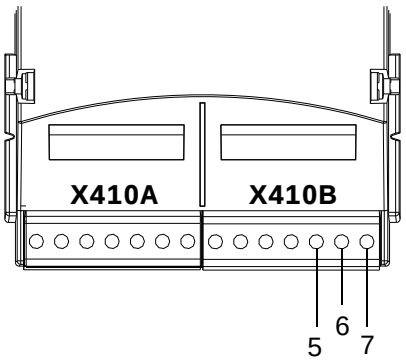
7.2 Cables

For the bus line, use twisted a cable with harness shield (**no foil shield**).

Attention: Control and communication cables must be kept physically separate from the power cables. The braided shield of the communication cable is to be connected to ground (PE) on both sides on a large area and with good conductivity.

7.3 Control terminal X410B

The system bus is connected via three sockets of the plug **X410B** on the EM-ABS-01 extension module.



Control terminal X410B		
Terminal	**Input/output**	**Description**
X410B.5	CAN-Low	CAN-Low (System bus)
X410B.6	CAN-High	CAN-High (System bus)
X410B.7	GND	CAN-GND (System bus)

7.4 Baud rate setting / line lengths

The Baud rate settings must be the same in all subscribers. The maximum Baud rate depends on the necessary total cable length of the system bus. The Baud rate is set up via parameter *Baud-Rate* **903** and defines the available cable length.

Operation mode	Function	max. line length
3 - 50 kBaud	Transmission rate 50 kBaud	1000 meters
4 - 100 kBaud	Transmission rate 100 kBaud	800 meters
5 - 125 kBaud	Transmission rate 125 kBaud	500 meters
6 - 250 kBaud	Transmission rate 250 kBaud	250 meters
7 - 500 kBaud	Transmission rate 500 kBaud	100 meters
8 - 1000 kBaud	Transmission rate 1000 kBaud	25 meters

A baud rate under 50 kBaud, as defined according to CANopen, is not sensible for the system bus as the data throughput is too low.

The maximum line lengths stated are guidelines.

Depending on the number of subscribers, the baud rate is limited. There are the following restrictions:

Up to and including	250 kBit/s:	not more than 64 subscribers
	500 kBit/s:	not more than 28 subscribers
	1000 kBit/s:	not more than 10 subscribers

The bus load must be considered in the projecting phase.

7.5 Setting the node address

A maximum of 63 slaves or frequency inverters with system bus can be operated on the system bus. Each frequency inverter is given a node ID, which may only exist once in the system, for its unambiguous identification. The setting of the system bus node ID is done via the parameter *Node-ID* **900**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
900	Node-ID	-1	63	-1

Thus, the system bus possesses a maximum number of 63 subscribers (Network nodes), plus one frequency inverter as a master.

Note: With the factory setting of parameter *Node-ID* **900** = -1, the system bus is deactivated for this frequency inverter.
If *Node-ID* **900** = 0 is set, the frequency inverter is defined as the master. Only one frequency inverter on the system bus may be defined as the master.

7.6 Functional overview

The system bus produces the physical connection between the frequency inverters. Logical communication channels are produced via this physical medium. These channels are defined via the identifiers. As CAN does not possess a subscriber-oriented, but a message-oriented addressing via the identifiers, the logical channels can be displayed via it.

In the basic state (factory setting) the identifiers are set according to the Predefined Connection Set of CANopen. These settings are aimed at one master serving all the channels. In order to be able to build up process data movement via the PDO channels between individual or a number of inverters (transverse movement), the setting of the identifiers in the subscribers has to be adapted.

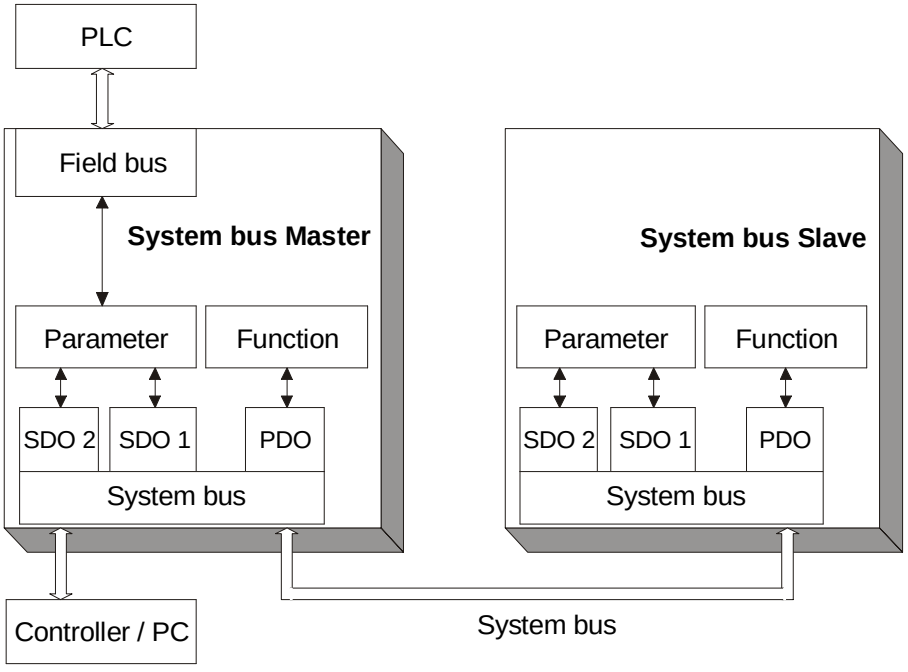
Note: The exchange of data is done message-oriented. A frequency inverter can transmit and receive a number of messages, identified via various identifiers.

As a special feature, the properties of the CAN bus mean that the messages transmitted by one subscriber can be received by a number of subscribers simultaneously. The error monitoring methods of the CAN bus result in the message being rejected by all recipients and automatically transmitted again if there is a faulty reception in one receiver.

7.7 Network management

The network management controls the start of all subscribers to the system bus. Subscribers can be started or stopped individually or jointly. For subscriber recognition in a CAL or CAN open system, the slaves on the system bus generate a starting telegram (boot-up report).
In the event of a fault, the slaves automatically transmit a fault report (emergency message).

For the functions of the network management, the methods and NMT telegrams (network management telegrams) defined according to CAN open (CiA DS 301) are used.



7.7.1 SDO channels (parameter data)

Each frequency inverter possesses two SDO channels for the exchange of parameter data. In a slave device, these are two server SDOs, in a device defined as a master a client SDO and a server SDO. Attention must be paid to the fact that only one master for each SDO channel may exist in a system.

Note: Only one master can initiate by the system bus an exchange of data via its client SDO.

The identifier assignment for the SDO channels (Rx/Tx) is done according to the Predefined Connection Set.
This assignment can be amended by parameterization, in order to solve identifier conflicts in a larger system in which further devices are on the CAN bus alongside the frequency inverters.

Attention: If a system in which a frequency inverter works as a master is produced, the identifier allocations for the SDO channel may not be altered.
In this way, an addressing of individual subscribers via the field bus/system bus path of the master frequency inverter is possible.

Parameters are read/written via the SDO channels. With the limitation to the SDO Segment Protocol Expedited, which minimizes the requirements of the parameter exchange, the transmittable data are limited to the uint / int / long types. This permits complete parameterization of the frequency inverters via the system bus, as all the settings and practically all the actual values are displayed via these data types.

7.7.2 PDO channels (process data)

Each frequency inverter possesses three PDO channels (Rx/Tx) for the exchange of process data.

The identifier assignment for the PDO channel (Rx/Tx) is done by default according to the Predefined Connection Set. This assignment corresponds to an alignment to a central master control.
In order to produce the logical channels between the devices (transverse movement) on the system bus, the amendment of the PDO identifiers for Rx/Tx is necessary.

Each PDO channel can be operated with time or SYNC control. In this way, the operation behavior can be set for each PDO channel:

The setting of the operation mode is done via the following parameters:
TxPDO1 Function **930**, *TxPDO2 Function* **932** and *TxPDO3 Function* **934**
RxPDO1 Function **936**, *RxPDO2 Function* **937** and *RxPDO3 Function* **938**

Operation mode	Function
0 - disabled	no exchange of data via the PDO channel (Rx and/or Tx)
1 - time-controlled	Tx-PDOs cyclically transmit according to the time specification Rx-PDOs are read in with Ta = 1 ms and forward the data received to the application
2 - SYNC controlled	Tx-PDOs transmit the data from the application that are then current after the arrival of the SYNC telegram. Rx-PDOs forward the last data received to the application after the arrival of the SYNC telegram.

For synchronous PDOs, the master (PC, PLC or frequency inverter) generates the SYNC telegram. The identifier assignment for the SYNC telegram is done by default according to the Predefined Connection Set. This assignment can be altered by parameterization.

7.8 Master functionality

An external control or a frequency inverter defined as a master (node ID = 0) can be used as a master. The fundamental tasks of the master are controlling the start of the network (boot-up sequence), generating the SYNC telegram and evaluating the emergency messages of the slaves.
Further, there can be access to the parameterization of all the frequency inverters on the system bus by means of a field bus connection via the client SDO of the master frequency inverter.

7.8.1 Control boot-up sequence, network management

The Minimum Capability Boot-Up method defined according to CANopen is used for the state control of the nodes.
This method knows the pre-operational, operational and stopped states.

After the initialization phase, all the subscribers are in the pre-operational state. The system bus master transmits the NMT command **Start-Remote-Node**. With this command, individual nodes or all the nodes can be started together. A frequency inverter defined as a master starts **all** the nodes with **one** command. After receipt of the Start Remote Node command, the subscribers change into the Operational state. From this time on, process data exchange via the PDO channels is activated.
A master in the form of a PLC/PC can start the subscribers on the system bus individually and also stop them again.

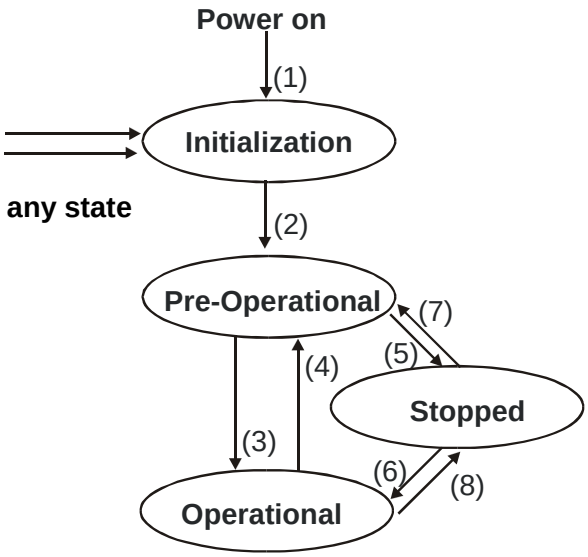
As the slaves on the system bus need different lengths of time to conclude their initialization phases (especially if external components exist alongside the frequency inverters), an adjustable delay for the change to Operational is necessary. The setting is done in a frequency inverter defined as a system bus master via *Boot-Up Delay* **904**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
904	Boot-up delay	3500 ms	50000 ms	3500 ms

Properties of the states:

State	Properties
Pre-Operational	Parameterization via SDO channel possible Exchange of process data via PDO channel not possible
Operational	Parameterization via SDO channel possible Exchange of process data via PDO channel possible
Stopped	Parameterization via SDO channel not possible Exchange of process data via PDO channel not possible

Note: Start-Remote-Node is cyclically transmitted with the set delay time by a frequency inverter defined as a system bus master, in order to put slaves added with a delay or temporarily separated from the network back into the Operational state.



After Power On and the initialization, the slaves are in the Pre-Operational state. The transition (2) is automatic. The system bus master (frequency inverter or PLC/PC) triggers the transition (3) to Operational state.
The transitions are controlled via NMT telegrams.

The identifier used for the NMT telegrams is "0" and may only be used by the system bus master for NMT telegrams. The telegram contains two data bytes.

Byte 0	Byte 1
CS (Command Specifier)	Node-ID

Identifier = 0

With the statement of the node ID ≠ 0, the NMT command acts on the subscriber selected via the node ID. If node ID = 0, all the subscribers are addressed. If Node-ID = 0, all nodes are addressed.

Transition	Command	Command Specifier
(3) , (6)	Start Remote Node	1
(4) , (7)	Enter Pre-Operational	128
(5) , (8)	Stop Remote Node	2
-	Reset Node	129
-	Reset Communication	130

Note: A frequency inverter defined as a system bus master only transmits the command "Start Remote Node" with node ID = 0 (for all subscribers). Transmission of the command is done after completion of the initialization phase and the time delay *Boot-Up Delay* **904** following it.

7.8.2 SYNC telegram, generation

If synchronous PDO's have been created on the system bus, the master must send the SYNC telegram cyclically. If a frequency inverter has been defined as a system bus master, the latter must generate the SYNC telegram. The interval for the SYNC telegram of a frequency inverter defined as the system bus master is adjustable. The SYNC telegram is a telegram without data.

The default identifier = 128 according to the Predefined Connection Set.

If a PC or PLC is used as a master, the identifier of the SYNC telegrams can be adapted by parameterization on the frequency inverter.
The identifier of the SYNC telegram must be set identically in all clients on the system bus.

The setting of the identifier of the SYNC telegram is done via parameter *SYNC-Identifier* **918**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
918	SYNC identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

Attention: The identifier range 129...191 may not be used as the emergency telegrams can be found there.

The temporal cycle for the SYNCH telegram is set on a frequency inverter defined as the system bus master via parameter *SYNC-Time* **919**.

Note: A setting of 0 ms for the parameter *SYNC-Time* **919** means "no SYNC telegram".

7.8.3 Emergency message, reaction

If a slave on the system bus suffers a fault, it transmits the emergency telegram. The emergency telegram marks the node ID for the identification of the failed node via its identifier and the existing fault message via its data contents (8 bytes).

After a fault has been acknowledged on the slave, the latter again transmits an emergency telegram with the data content zero.

The emergency telegram has the identifier 128 + node ID (= 129 ... 191)

The system bus master evaluates the emergency telegrams of the slaves. Its reaction to an emergency telegram can be set with *Emergency Reaction* **989**.

Operation mode	Function
0 - Error	The system bus master receives the emergency telegram and switches-off.
1 - No Error	The Emergency Telegram is displayed as a warning.
2 - Ignore	The Emergency Telegram is ignored.

Operation mode - parameter 989 = 0 – Error

Behavior of the system bus master in the case of *Emergency Reaction* **989** = 0 - Error:

As soon as the system bus master receives an emergency telegram, it also switches to failure mode and reports the failed subscriber on the basis of its ID via the kind of error. Only the subscriber is reported, not the cause of the error.

The fault message on the system bus master via *Type of error* **260** is **21nn** with **nn = node ID** (hexadecimal) of the slave where a fault shutdown has occurred.
In addition, the system bus master reports the warning Sysbus (0x2000) via *Warning Status* **270** Bit 13.

If a fault shutdown occurs on a number of slaves, the first slave to transmit its emergency telegram is displayed on the system bus master.

Operation mode - parameter 989 = 1 – No Error

Behavior of system bus master in the case of *Emergency Reaction* **989** = 1 / No Error:

As soon as the system bus master receives an emergency telegram, it reports the warning Sysbus (0x2000) via *Warning status* **270** Bit 13.

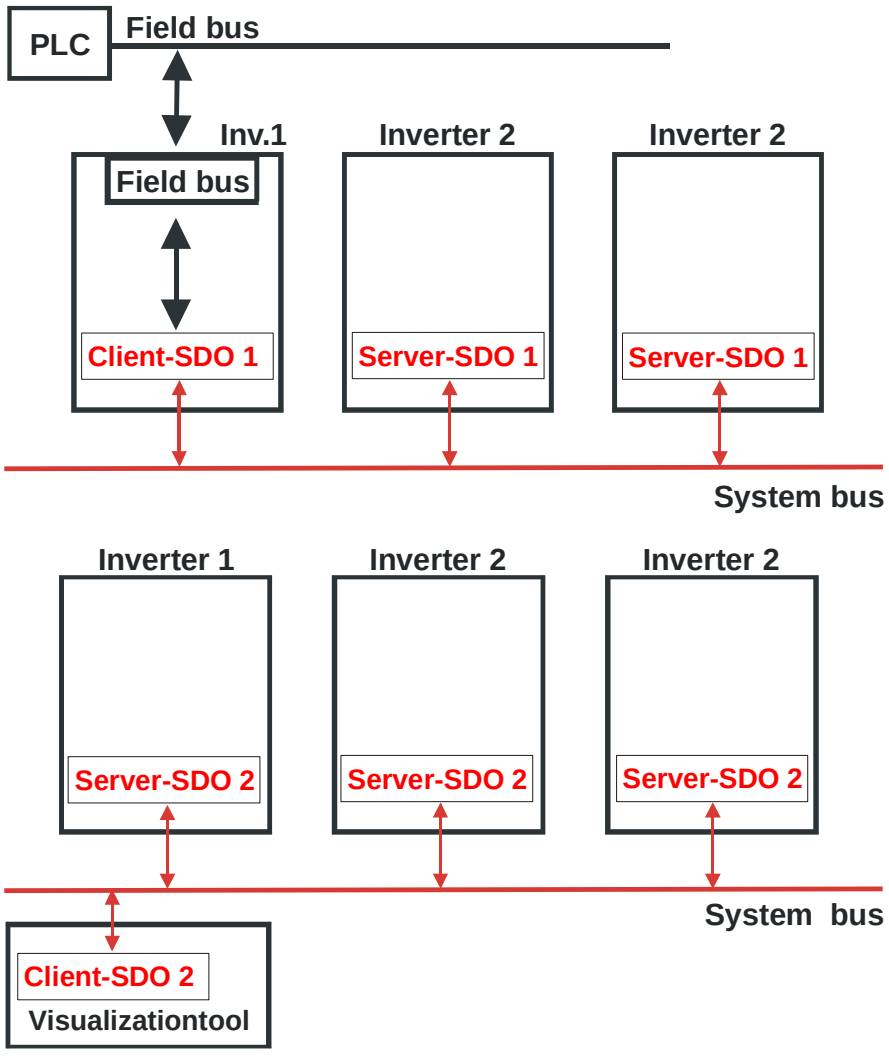
Note: In both cases, the Boolean variable SysbusEmergency with source number 730 is set to TRUE in the system bus master. It can be used in the system bus master and (in transmission via a TxPDO) in the slaves for a defined shutdown.
SysbusEmergency is also set if the system bus master breaks down.
Resetting of SysbusEmergency is done with the fault acknowledgment.

7.8.4 Client SDO (system bus master)

Each subscriber on the system bus can be addressed via the SDO channels. In this way, each subscriber can be addressed and parameterized by one master via its client SDO1. All the parameters of the data types uint/int/long are accessible. String parameters **cannot** be processed. If a frequency inverter has been defined as a system bus master, each subscriber on the system bus in this frequency inverter can be addressed by means of a field bus connection (RS232, RS485, Profibus-DP) via its client SDO1.

Note: The second SDO channel SDO2 of the frequency inverters is planned for the parameterization of the frequency inverters via a visualization tool on the system bus.

The service used is SDO Segment Protocol Expedited according to CANopen. A frequency inverter defined as a system bus master automatically generates the correct telegrams. If the SDO channel is operated via a PLC/PC on the system bus, the telegrams must be generated according to the specification.



7.9 Slave functionality

7.9.1 Implement boot-up sequence, network management

7.9.1.1 Boot-up message

After the initialization, each slave on the system bus transmits its boot-up message (heartbeat message).

Note: The boot-up telegram has the identifier 1792 + node ID and a data byte with contents = 0x00.

This telegram is irrelevant if a PLC/PC with CANopen functionality is used as a master. A frequency inverter defined as a system bus master **does not** evaluate the boot-up message.

7.9.1.2 Position control

The identifier used for the NMT telegrams is "0" and may only be used by the system bus master for NMT telegrams. The telegram contains two data bytes.

Byte 0	Byte 1
CS (Command Specifier)	Node-ID

Identifier = 0

With the statement of the node ID ≠ 0, the NMT command acts on the subscriber selected via the node ID. If node ID = 0, all the subscribers are addressed. If Node-ID = 0, **all** subscribers are addressed.

Transition	Command	Command Specifier
(3),(6)	Start Remote Node	1
(4),(7)	Enter Pre-Operational	128
(5),(8)	Stop Remote Node	2
-	Reset Node	129
-	Reset Communication	130

Attention: The reset node and reset communication command specified according to DS 301 lead to a change to Pre-Operational via Initialization in the frequency inverters. There is a new boot-up message.

After a slave has received the command "Start Remote Node", it activates the PDO channels and is ready for the exchange of process data.

7.9.2 Process SYNC telegram

If synchronous PDO's have been created in a frequency inverter, their processing is synchronized with the SYNC telegram. The Sync event can either by a SYNC telegram or a RxPDO telegram and is set up via **1180** *Operation mode* synchronization.
The SYNC telegram is generated by the system bus master and is a telegram without data or 1 byte data. The data byte is ignored.

The identifier is 128 according to the Predefined Connection Set.

If a PC or PLC is used as a master, the identifier of the SYNC telegrams can be adapted by parameterization on the frequency inverter. The identifier of the SYNC telegram must be set identically in all clients on the system bus.

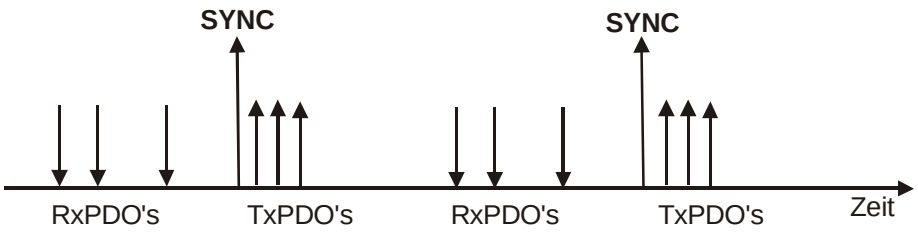
Attention: The identifier range 129..191 may not be used as this range is used for the emergency telegrams.

The setting of the identifier of the SYNC telegram is done via parameter *SYNC-Identifier* **918**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
918	SYNC identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

The data of the Rx-PDO's are forwarded to the application after the arrival of the SYNC telegram. At the same time, the Tx-PDO's with the currently available data from the application are sent.



This method enables pre-occupancy of set points in the system bus subscribers and a synchronous / parallel take-over of the data.

7.9.3 Selecting the synchronization source

The operating system (OS) of the frequency inverter can be synchronized with a PLC or another device. Synchronizing the operating system will improve the operating behavior of the machine.
Synchronization via CANopen:
If CANopen is used without system bus, synchronization can be turned on or off. Synchronization is done via CANopen SYNC telegrams.
Synchronization via system bus:
If CANopen is used simultaneously with system bus, synchronization can be done either on CANopen, system bus or turned off. Synchronization is effected through system bus SYNC telegrams or system bus RxPDO telegrams.
Note: If the operating system is synchronized via CANopen, the CANopen master must support the CANopen synchronization mechanisms.

OS_SyncSource **1452**	
Operation mode	**Function**
0 - Auto	The synchronization source is selected automatically by the frequency inverter.
1 - CANopen	The operating system is synchronized via CANopen. **Factory setting.**
2 - System bus	The operating system is synchronized via system bus.
3 - Off	The operating system is not synchronized.

Operation mode **Auto**: Selection is made via a decision table:

CANopen active	**System bus active**	**Synchronization**
Yes	Yes	➔ Synchronization via CANopen
Yes	No	
No	Yes	➔ Synchronization via system bus
No	No	➔ No synchronization activated.

Status "Synchronization via CANopen active" is identified via parameter setting **387** *CAN Node Number* >1 and a running synchronous PDO.
Status "Synchronization via system bus active" is identified via parameter setting **900** *System bus node ID* >1. In addition, parameter **1180** *Synchronization* must be set to SYNC or RxPDO.

The source of the operating system (OS) synchronization is set via **1180** *Operation mode*. This defines the Sync event (RxPDO or SYNC telegram), which will be used for synchronization of PDOs:

930 *TxPDO1 Function* **936** *RxPDO1 Function*
932 *TxPDO2 Function* **937** *RxPDO2 Function*
934 *TxPDO3 Function* **938** *RxPDO3 Function*

Synchronization *Operation mode* **1180**	
Operation mode	**Function**
0 - Off	Synchronization via system bus is deactivated. **Factory setting.**
1 - RxPDO1	Synchronization via system bus is activated via RxPDO1.
2 - RxPDO2	Synchronization via system bus is activated via RxPDO2.
3 - RxPDO3	Synchronization via system bus is activated via RxPDO3.
10 - SYNC	Synchronization via system bus is activated via SYNC.

7.9.3.1 Settings for electronic gear in configuration x40

If the function "electronic gear" of the positioning in ACU (configuration x40) is used in a slave, synchronization via SYNC or RxPDO1 must be set via system bus. Please check the following settings:

Use of RxPDO A Master Identifier must correspond to the Slave Identifier.	
Master	**Slave**
925 *TxPDO1 Identifier* **926** *TxPDO2 Identifier* **927** *TxPDO3 Identifier*	**924** *RxPDO1 Identifier*
930 *TxPDO1 Function* **932** *TxPDO2 Function* **934** *TxPDO3 Function*	**936** *RxPDO1 Function* = 1 – controlled by SYNC (recommended)
	1180 *Operation mode* = 1- RxPDO

Use of SYNC The Master Sync Identifier must correspond to the Slave Sync Identifier (e.g. 0 → Predefined Set 0x80 = 128).	
Master	**Slave**
	936 *RxPDO1 Function* = 1 – controlled by SYNC (recommended)
918 *Sync Identifier* **919** *Sync Time*	**918** *Sync Identifier* **1180** *Operation mode*= 10-SYNC

Note:
1180 *Operation mode* ensures synchronization of the operating systems of different devices and must be set up in configuration x40 in one of the two ways described.
936 *RxPDO1 Function* should be set to "1 – controlled by SYNC" in order to synchronize the master position with the OS in the slave. Although this setting is optional, BONFIGLIOLI VECTRON recommends setting this parameter accordingly.

7.9.3.2 Scope sources

For the VPlus Scope function, the following sources are available for diagnosis:

Operation mode		Function
731 -	B: Sync. OS <-> Sysbus Ok	1 = Synchronization OS to system bus OK, 0 = Synchronization OS to system bus not OK
852-	SysBus SYNC time [us]	Represents the synchronization time cycles. Should show the set SYNC time or TxPDO of the transmitting master.
853	SysBus SYNC position 1ms Task [us]	Represents the synchronization time within 1 ms. Should be constant with minor deviations.
854-	B: Sync. OS <-> CANopen Ok	1 = Synchronization OS to CANopen OK, 0 = Synchronization OS to CANopen not OK
848-	SYNC time [us]	Represents the synchronization time cycles. Should show the SYNC time of object 0x1006.
849-	CANopen SYNC position 1ms Task [us]	Represents the synchronization time within 1 ms. Should be constant with minor deviations.

Please also refer to the manual of the CM-CAN module if synchronization via CM-CAN is used.

7.9.4 Emergency-Message, fault shutdown

As soon as a fault shutdown occurs in a slave frequency inverter, the emergency telegram is transmitted. The emergency telegram marks the node ID for the identification of the failed node via its identifier and the existing fault message via its data contents (8 bytes).

The emergency telegram has the identifier 128 + node ID.

After a fault acknowledgment, another emergency telegram is transmitted, with the data content (Byte 0 ...7) being set to "0" this time. This identifies the subscriber's repeated readiness for operation. If a further fault occurs subsequently, it is transmitted in a new emergency telegram.

The acknowledgment sequence is based on the definitions according to CANopen.

Data contents of the emergency telegram:

Emergency telegram		
Byte	**Value**	**Meaning**
0	0x00	low-byte error code
1	0x10	high-byte error code
2	0x80	Error register
3	0x00	-
4	0x00	-
5	0x00	-
6	0xnn	internal error code, low-byte
7	0xmm	internal error code, high-byte

Bytes 0, 1 and 2 are firmly defined and compatible with CANopen.
Bytes 6/7 contain the product specific VECTRON error code.

Error code	= 0x1000	= general error
Error register	= 0x80	= manufacturer-dependent error

The explanation and description of the product-specific VECTRON error code can be found in the annex "Error messages".

7.9.5 Server-SDO1/SDO2

The communication channel for the exchange of parameter data is the SDO channel. Communication works according to the client/server model. The server is the subscriber holding the data (here the frequency inverter), the client the subscriber requesting or wanting to alter the data (PLC, PC or frequency inverter as system bus master).

For the frequency inverter, two server SDO channels have been implemented.
The first SDO channel **SDO1** is used for the parameterization of the PLC/PC as a master or frequency inverter with field bus connection as a system bus master.
The second SDO channel **SDO2** is reserved for a visualization tool for parameterization. An exchange of data can only be implemented by the master via a client SDO.

The SDO channels are stipulated for the server SDO's via identifiers according to the Predefined Connection Set to CANopen. As CANopen only provides for and defines one SDO channel in the Predefined Connection Set, the second SDO channel can be deactivated.
In addition, the number of system bus subscribers and the adjustable node ID are limited to 63.

Identifier assignment according to the Predefined Connection Set:

Identifier Rx-SDO = 1536 + Node-ID	(Node ID = 1 ... 127, Identifier = 1537 ... 1663)
Identifier Tx-SDO = 1408 + Node ID	(Node ID = 1 ... 127, Identifier = 1409 ... 1535)

Identifier assignment for SDO1/SDO2 compatible with the Predefined Connection Set:

Identifier Rx-SDO1 = 1536 + Node ID	(Node ID = 1 ... 63, Identifier = 1537 ... 1599)
Identifier Tx-SDO1 = 1408 + Node ID	(Node ID = 1 ... 63, Identifier = 1409 ... 1471)
Identifier Rx-SDO2 = 1600 + Node ID	(Node ID = 0 ... 63, Identifier = 1600 ... 1663)
Identifier Tx-SDO2 = 1472 + Node ID	(Node ID = 0 ... 63, Identifier = 1472 ... 1535)

This corresponds to the factory settings of the frequency inverters for the SDO's.
The node ID = 0 for SDO2 is the system bus master.

Attention: The SDO2 must be deactivated in a CANopen system in order not to generate any compatibility problems.

If a frequency inverter has been defined as the system bus master, the above settings for the SDO1 must be maintained in all the frequency inverters. In this way, access to the parameterization of the frequency inverters via a field bus connection on the master frequency inverter is possible.
The client SDO1 in the master frequency inverter addresses the server SDO1 of the slaves via the above identifiers.

Attention: The identifiers for a visualization tool on the second SDO channel SDO2 cannot be changed.

If a PC or a PLC is used as a master, the identifiers of the **Rx/Tx-SDO1** can be adapted by parameterization on the frequency inverter.

Attention: Identifiers may only be assigned once, i.e. no double assignments.

The identifier range 129...191 may not be used as the emergency telegrams can be found there.

The setting of the identifiers of the RxSDO1 is done via the parameter *RxSDO1-Identifier* **921**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
921	RxSDO1 identifier	0	2047	0

The setting of the identifiers of the TxSDO1 is done via parameter number **922**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
922	TxSDO1 identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

The second SDO channel can be deactivated via the *SDO2 Set Active* **923**.

Operation mode	Function
0 - SDO2 deactivated	Communication channel deactivated
1 - SDO2 activated	Communication channel activated for the visualization tool

The identifier assignment for the second SDO channel is always to the specification:

Identifier Rx-SDO2 = 1600 + Node ID
Identifier Tx-SDO2 = 1472 + Node ID

Note: In this way, firm identifiers via which communication takes place are available for the visualization tool.

7.10 Communication channels, SDO1/SDO2

7.10.1 SDO telegram (SDO1/SDO2)

The service used for the exchange of parameter data is **SDO Segment Protocol Expedited**. The data (type uint, int, long) are exchanged in a telegram.

Access to the parameters in the frequency inverters with a statement of parameter number and data set is displayed via the addressing defined for object access pursuant to the specifications of CANopen via Index/Sub-Index.
Index = parameter number / Sub index = data set.

The data to be transmitted have a length of 2 bytes for uint/int and 4 Bytes for long. For simplification and standardization, 4 bytes are always transmitted.

The data are on bytes 4...7 of the SDO telegram.
- uint/int variables are transmitted in bytes 4 and 5 with bytes 6 und 7 = 0.
- long variables are transmitted in bytes 4...7.

Writing parameters:

Client ➔ Server SDO Download (expedited)

0	1	2	3	4	5	6	7
Control byte	Parameter number		Data Set	Data			
0x22	LSB	MSB	0xnn	LSB			MSB
uint/int				LSB	MSB	0x00	0x00
long				LSB	...	...	MSB

Server ➔ Client Download Response ➔ writing process free of errors

0	1	2	3	4	5	6	7
Control byte	Parameter number		Data Set	Data			
0x60	LSB	MSB	0xnn	0			

Server ➔ Client Abort SDO Transfer ➔ writing process with error

0	1	2	3	4	5	6	7
Control byte	Parameter number		Data Set	Data			
0x80	LSB	MSB	0xnn	Code	0	0	0

The error code is stated in byte 4 in a faulty reading process.
(See table, failure codes).

Attention: Control byte 0x22 for the identification "SDO Download expedited" does not consider the bits "s" (data size indicated) and "n" (number of bytes not containing data). If set, they are ignored. The user is responsible for the number of bytes matching the type of data.

Reading parameters:

Client ➔ Server SDO Upload (expedited)

0	1	2	3	4	5	6	7
Control byte	Parameter number		Data Set	Data			
0x40	LSB	MSB	0xnn	0			

Server ➔ Client Upload Response ➔ reading process without errors

0	1	2	3	4	5	6	7
Control byte	Parameter number		Data Set	Data			
0x42	LSB	MSB	0xnn	LSB			MSB
uint/int				LSB	MSB	0x00	0x00
long				LSB	...	...	MSB

Server ➔ Client Abort SDO Transfer ➔ reading process faulty

0	1	2	3	4	5	6	7
Control byte	Parameter number		Data Set	Data			
0x80	LSB	MSB	0xnn	Code	0	0	0

The error code is stated in byte 4 in a faulty reading process.
(See table, failure codes).

Error codes	
Code	**Description**
1	inadmissible parameter value
2	inadmissible data set
3	Parameter not readable
4	Parameter not writeable
5	read error EEPROM
6	write error EEPROM
7	checksum error EEPROM
8	parameter cannot be written while the drive is running
9	values of the data sets differ from one another
10	wrong parameter type
11	unknown parameter
12	BCC error in VECTRON bus protocol
15	unknown error
20	system bus subscriber not available only in access via field bus connection
21	string parameter not admissible only in access via VEC-TRON bus protocol

Errors marked in the table are generated by the field bus side, not in the Abort SDO Transfer of the system bus.

7.10.2 Communication via field bus actuation (SDO1)

If a frequency inverter has been defined as the system bus master and equipped with a field bus interface, access to the parameterization of all the subscribers in existence on the system bus is possible by means of this field bus interface via the first SDO channel (SDO1). An extension has been created in the protocol frame of the field buses for this purpose.

Attention: The prerequisite for this mechanism is that the identifier setting for the first SDO channel (SDO1) corresponds to the Predefined Connection Set. The parameter addressed must also be existent in the system bus master.

7.10.2.1 Profibus-DP

If an object with communication channel (motor car area) is used in Profibus-DP, access to all the other subscribers on the system bus can be done via it. The structure of the motor car area permits an additional addressing of a system bus subscriber. This is done by the use of an unused byte in the motor car area.

PKW area

0	1	2	3	4	5	6	7
PKE		Index	-	Data			
AK/SPM	Parameter number	Data Set	Node ID System bus				

Byte 3 is used to transmit the node ID of the required subscriber on the system bus. If byte 3 = 0, the master inverter of the system bus is addressed. The display is binary (0...63).

7.10.2.2 RS232/RS485 with VECTRON bus protocol

In the VECTRON bus protocol, there is a byte in the telegram header that is always transmitted with 0 as a standard feature.

ENQUIRY

0	1	2	3	4	5	6
Address	0	p	n	n	n	ENQ
	Node ID system bus	Data Set	Parameter number			

SELECT

0	1	2	3	4			
Address	STX	0	p	n	n	n	...
		Node-ID System bus	Data Set	Parameter number			

Byte 1 in the enquiry and byte 2 in the select telegram are not defined and are used to transmit the node ID of the required subscriber on the system bus. If this byte = 0, the master inverter of the system bus is addressed. The display is ASCII corresponding to the conventions for the display of the address in the VECTRON bus protocol.

Note: If there is an NAK fault message, the error is to be read out from the system bus master with node ID = 0 via parameter 11.

Display of node ID system bus in the BONFIGLIOLI VECTRON bus protocol:

System bus Node-ID					
System bus address	**(ASCII) character**	**HEX value**	**System bus address**	**(ASCII) character**	**HEX value**
1	A	41	31	_	5F
2	W	42	32	`	60
3	C	43	33	a	61
4	D	44	34	b	62
5	E	45	35	c	63
6	F	46	36	d	64
7	G	47	37	e	65
8	H	48	38	f	66
9	I	49	39	g	67
10	J	4A	40	h	68
11	K	4B	41	i	69
12	L	4C	42	j	6A
13	M	4D	43	k	6B
14	N	4E	44	l	6C
15	O	4F	45	m	6D
16	P	50	46	n	6E
17	Q	51	47	o	6F
18	R	52	48	p	70
19	S	53	49	q	71
20	D	54	50	r	72
21	U	55	51	s	73
22	V	56	52	t	74
23	W	57	53	u	75
24	X	58	54	v	76
25	Y	59	55	w	77
26	Z	5A	56	x	78
27	[	5B	57	y	79
28	\	5C	58	z	7A
29	]	5D	59	{	7B
30	^	5E	60	|	7C
			61	}	7D
			62	~	7E
			63	□	7F

7.11 Process data channels, PDO

7.11.1 Identifier assignment process data channel

The process channel for the exchange of process data under CANopen is the PDO channel. Up to three PDO channels with differing properties can be used in one device.

The PDO channels are defined via identifiers according to the Predefined Connection Set to CANopen:

Identifier 1. Rx-PDO = 512 + Node ID
Identifier 1. Tx-PDO = 384 + Node ID

Identifier 2. Rx-PDO = 768 + Node ID
Identifier 2. Tx-PDO = 640 + Node ID

Identifier 3. Rx-PDO = 1024 + Node ID
Identifier 3. Tx-PDO = 896 + Node ID

This corresponds to the factory settings of the frequency inverters for the Rx/Tx-PDO's. This occupancy is aligned to an external master (PLC/PC) serving all the channels.
If the PDO channels are used for a connection of the frequency inverters amongst one another, the identifiers are to be set accordingly by parameterization.

Attention: Identifiers may only be assigned once, i.e. no double assignments.

The identifier range 129...191 may not be used as the emergency telegrams can be found there.

Setting of the identifiers of the Rx/TxPDOs:

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
924	RxPDO1 Identifier	0	2047	0
925	TxPDO1 Identifier	0	2047	0
926	RxPDO2 Identifier	0	2047	0
927	TxPDO2 Identifier	0	2047	0
928	RxPDO3 Identifier	0	2047	0
929	TxPDO3 Identifier	0	2047	0

The setting "0" results in identifier assignment according to the Predefined Connection Set.

7.11.2 Operation modes process data channel

The sending/receiving behavior can be time-controlled or controlled via a SYNC telegram. The behavior can be parameterized for each PDO channel.

Tx-PDOs can work time-controlled or SYNC-controlled. Time-controlled TxPDO sends its data at the set time intervals. A SYNC-controlled TxPDO will send its data once a SYNC-telegram is received.

RxPDOs in the time controlled setting forward the received data to the application immediately. If an RxPDO has been defined as SYNC controlled, it forwards its received data to the application after the arrival of a SYNC telegram.

Settings TxPDO1/2/3

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
931	TxPDO1 Time	1 ms	50000 ms	8 ms
933	TxPDO2 Time	1 ms	50000 ms	8 ms
935	TxPDO3 Time	1 ms	50000 ms	8 ms

The setting of the operation mode is done via the following parameters:
TxPDO1 Function **930**, *TxPDO2 Function* **932** and *TxPDO3 Function* **934**

Operation mode	Function
0 - Not Active	No data are sent.
1 - Controlled by time	In the cycle of the adjusted time interval the data are sent.
2 - Controlled by SYNC	To arrival of a SYNC telegram the data are sent.

Settings RxPDO1/2/3

The setting of the operation mode is done via the following parameters:
RxPDO1 Function **936**, *RxPDO2 Function* **937** and *RxPDO3 Function* **938**

Operation mode	Function
0 - Controlled by time	The received data are passed on immediately.
1 - Controlled by SYNC	After arrival of a SYNC telegram the received data are passed on

Note: In the "controlled by time" operation mode, there is a polling of the received data with the trigger cycle of Ta = 1 ms.

7.11.3 Timeout monitoring process data channel

Each frequency inverter monitors its received data for whether they are updated within a defined time window.
The monitoring is done onto the SYNC telegram and the RxPDO channels.

Monitoring SYNC / RxPDOs

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
939	SYNC timeout	0 ms	60000 ms	0 ms
941	RxPDO1 Timeout	0 ms	60000 ms	0 ms
942	RxPDO2 Timeout	0 ms	60000 ms	0 ms
945	RxPDO3 Timeout	0 ms	60000 ms	0 ms

Setting "0" means no timeout monitoring.

Attention: There is only monitoring for the SYNC telegram if at least one RxPDO or one TxPDO channel is defined as SYNC controlled.

If a timeout period is exceeded, the frequency inverter switches to failure mode and reports one of the faults:

F2200 System bus Timeout SYNC

F2201 System bus Timeout RxPDO1
F2202 System bus Timeout RxPDO2
F2203 System bus Timeout RxPDO3

7.11.4 Communication relationships of the process data channels

Regardless of the process data to be transmitted, the communication relationships of the process data channels must be defined. The connection of PDO channels is done via the assignment of the identifiers. The identifiers of Rx-/Tx-PDO must match in each case.

Generally, there are two possibilities:

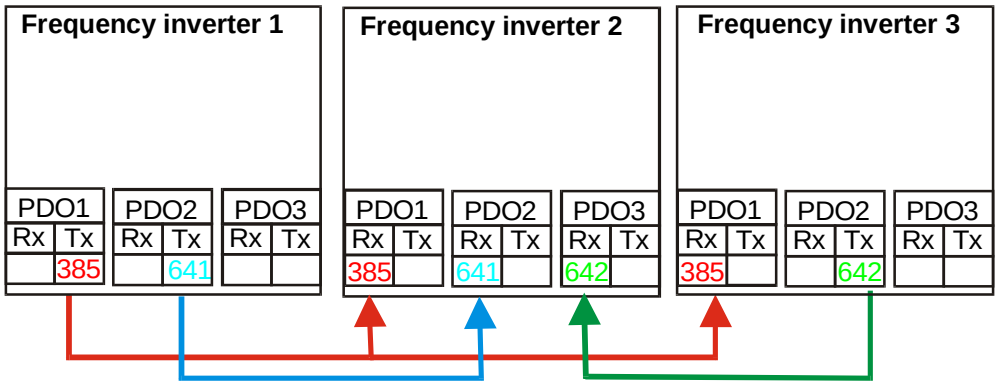
- **one** Rx-PDO to **one** Tx-PDO (one to one)
- connect **several** Rx-PDO's to **one** TxPDO (one to many)

This process is documented in a tabular form via a **communication relationship list**.

Example:

Frequency inverter 1		**Frequency inverter 2**		**Frequency inverter 3**	
PDO	Identifier	PDO	Identifier	PDO	Identifier
TxPDO1	**385**	TxPDO1		TxPDO1	
RxPDO1		**RxPDO1**	**385**	**RxPDO1**	**385**
TxPDO2	**641**	TxPDO2		**TxPDO2**	**642**
RxPDO2		**RxPDO2**	**641**	RxPDO2	
TxPDO3		TxPDO3		TxPDO3	
RxPDO3		**RxPDO3**	**642**	RxPDO3	

Attention: All the TxPDOs used must have different identifiers !!!
The Identifier must be clear in the system bus network.



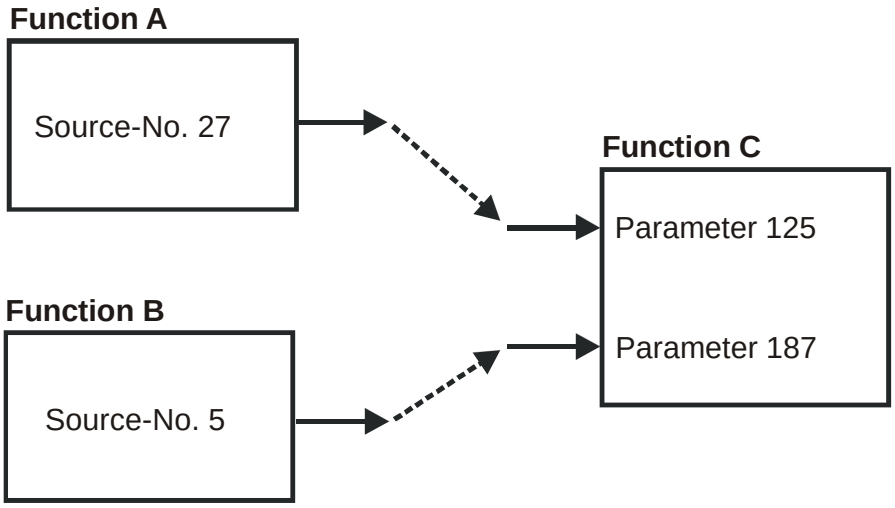
7.11.5 Virtual links

A PDO telegram contains 0 ...8 data bytes according to CANopen. A mapping for any kind of objects can be done in these data bytes.

For the system bus, the PDO telegrams are firmly defined with 8 data bytes. The mapping is not done via mapping parameters as with CANopen, but via the method of sources and links.

Each function provides its output data via a source. These sources are defined via source numbers. The input data of functions are defined via parameters. The link of a data input to a data output is done via the assignment of parameters to source numbers.

Example 1:

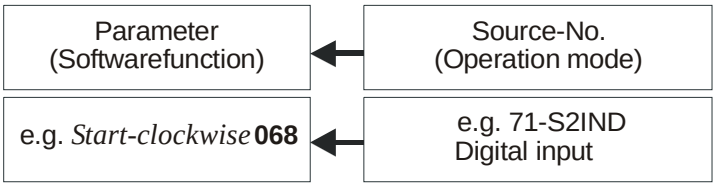


In example 1, the two inputs of function C are linked to the outputs of the functions A and B. The parameterization for this connection is thus:

Function C

Parameter 125 = Source-No. 27
Parameter 187 = Source-No. 5

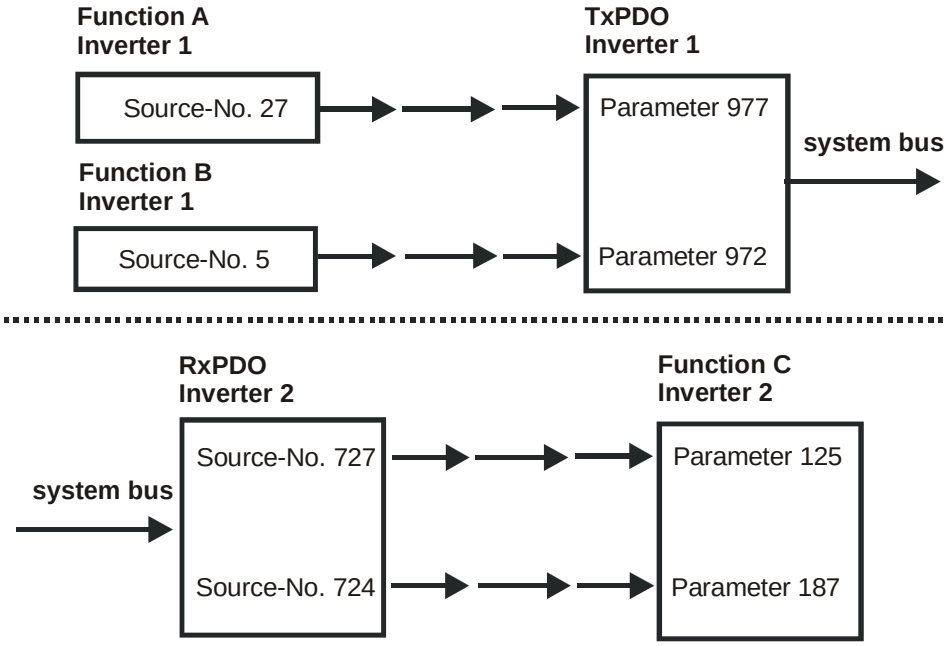
Example of a virtual connection in VPlus:



The assignment of the operation modes to the software functions available can be adapted to the application in question.

For the system bus, the input data of the TxPDOs are also displayed as input parameters and the output data of the RxPDOs as sources.

Example 2:



Example 2 displays the same situation as Example 1. But now, the functions A and B are in frequency inverter 1 and function C in frequency inverter 2. The connection is done via a TxPDO in frequency inverter 1 and a RxPDO in frequency inverter 2. Thus, the parameterization for this connection is:

Frequency inverter 1

Parameter 977 = Source-No. 27
Parameter 972 = Source-No. 5

Frequency inverter 2

Parameter 125 = Source-No. 727
Parameter 187 = Source-No. 724

As the links with the system used exceed the device limits, they are termed "virtual links".

The virtual links with the possible sources are related to the Rx/TxPDO channels. For this purpose, the eight bytes of the Rx-/TxPDOs are defined structured as inputs and sources. This exists for each of the three PDO channels.

Each transmit PDO and receive PDO can be occupied as follows:

4 Boolean variables

or

4 uint / int variables

or

2 long variables

or

a mixture paying attention to the eight bytes available

Assignment data type / number of bytes:

Assignment	
Data type	**Length**
Boolean	2 Bytes
uint/int	2 Bytes
long	4 Bytes

7.11.5.1 Input parameters of the TxPDOs for data to be transmitted

The listed parameters can be used for determining the data that are to be transported there for each position in the TxPDO telegrams. The setting is done in such a way that a source number is entered for the required data in the parameters.

TxPDO1 Byte	P. No. Boolean input	TxPDO1 Byte	P. No. uint/int input	TxPDO1 Byte	P. No. long input
0	**946**	0	**950**	0	
1	Boolean1	1	Word1	1	**954**
2	**947**	2	**951**	2	
3	Boolean2	3	Word2	3	Long1
4	**948**	4	**952**	4	
5	Boolean3	5	Word3	5	**955**
6	**949**	6	**953**	6	
7	Boolean4	7	Word4	7	Long2

TxPDO2 Byte	P. No. Boolean input	TxPDO2 Byte	P. No. uint/int input	TxPDO2 Byte	P. No. long input
0	**956**	0	**960**	0	
1	Boolean1	1	Word1	1	**964**
2	**957**	2	**961**	2	
3	Boolean2	3	Word2	3	Long1
4	**958**	4	**962**	4	
5	Boolean3	5	Word3	5	**965**
6	**959**	6	**963**	6	
7	Boolean4	7	Word4	7	Long2

TxPDO3 Byte	P. No. Boolean input	TxPDO3 Byte	P. No. uint/int input	TxPDO3 Byte	P. No. long input
0	**966**	0	**972**	0	
1	Boolean1	1	Word1	1	**976**
2	**967**	2	**973**	2	
3	Boolean2	3	Word2	3	Long1
4	**968**	4	**974**	4	
5	Boolean3	5	Word3	5	**977**
6	**969**	6	**975**	6	
7	Boolean4	7	Word4	7	Long2

Note: Depending on the selected data information the percentages values are displayed via the uint/int inputs.

With this method, there are up to three possibilities for a meaning of the contents of the individual bytes. Each byte may only be used for one possibility.

To ensure this, the processing of the input links is derived from the setting.
If an input link has been set to the fixed value of zero, it is **not** processed.

The settings for the fixed value zero are:

Source =	7	(FALSE)	for Boolean variables
Source =	9	(0)	for uint, int, long variables

This is, at the same time, the factory setting.

Examples Boolean source

Boolean source	
Source	**Data**
6	TRUE
7	FALSE
70	Contact input 1
71	Contact input 2
72	Contact input 3
161	Run signal
163	Reference value reached
164	Set frequency reached (P. 510)

Examples uint / int source

unit / int source	
Source	**Data**
9	0
63	Reference Percentage 1
64	Reference Percentage 2
52	Percentage MFE1
133	Output percentage ramp
137	Output reference percentage channel
138	Output actual percentage channel
740	Control word
741	Status word

Examples long source

long source	
Source	**Data**
9	0
0	Output frequency ramp
1	Fixed frequency 1
5	Reference line value
62	Output Frequency reference value channel
50	Reference Frequency MFE1

7.11.5.2 Source numbers of the RxPDOs for received data

Equivalent to the input links of the TxPDOs, the received data of the RxPDOs are displayed via sources or source numbers. The sources existing in this way can be used in the frequency inverter via the local input links for the data targets.

RxPDO1 Byte	Source no. Boolean value	RxPDO1 Byte	Source no. uint/int value	RxPDO1 Byte	Source no. long Value
0	**700**	0	**704**	0	
1	Boolean1	1	Word1	1	**708**
2	**701**	2	**705**	2	
3	Boolean2	3	Word2	3	Long1
4	**702**	4	**706**	4	
5	Boolean3	5	Word3	5	**709**
6	**703**	6	**707**	6	
7	Boolean4	7	Word4	7	Long2

RxPDO2 Byte	Source no. Boolean value	RxPDO2 Byte	Source no. uint/int value	RxPDO2 Byte	Source no. long value
0	**710**	0	**714**	0	
1	Boolean1	1	Word1	1	**718**
2	**711**	2	**715**	2	
3	Boolean2	3	Word2	3	Long1
4	**712**	4	**716**	4	
5	Boolean3	5	Word3	5	**719**
6	**713**	6	**717**	6	
7	Boolean4	7	Word4	7	Long2

RxPDO3 Byte	Source no. Boolean value	RxPDO3 Byte	Source no. uint/int value	RxPDO3 Byte	Source no. long value
0	**720**	0	**724**	0	
1	Boolean1	1	Word1	1	**728**
2	**721**	2	**725**	2	
3	Boolean2	3	Word2	3	Long1
4	**722**	4	**726**	4	
5	Boolean3	5	Word3	5	**729**
6	**723**	6	**727**	6	
7	Boolean4	7	Word4	7	Long2

With this method, there are up to three possibilities for a meaning of the contents of the individual bytes. Each byte may only be used for one possibility.

Note: Depending on the selected data information the percentages values are displayed via the uint/int inputs.

7.11.5.3 Examples of virtual links

Example 1:

Frequency inverter 1				Frequency inverter 2		
Source no.	**Input link**	**TxPDO1 Byte**		**RxPDO1 Byte**	**Source - No.**	**Target**
Control word **740**	950	0	→	0	704	Control input, Control word **99**
		1		1		
		2		2		
		3		3		
Output reference frequency channel **62**	955	4	→	4	709	Ramp input, Line set value **137**
		5		5		
		6		6		
		7		7		

Parameter 950 = Source-No. 740
Parameter 955 = Source-No. 62

Parameter 99 = Source-No. 704
Parameter 137 = Source-No. 709

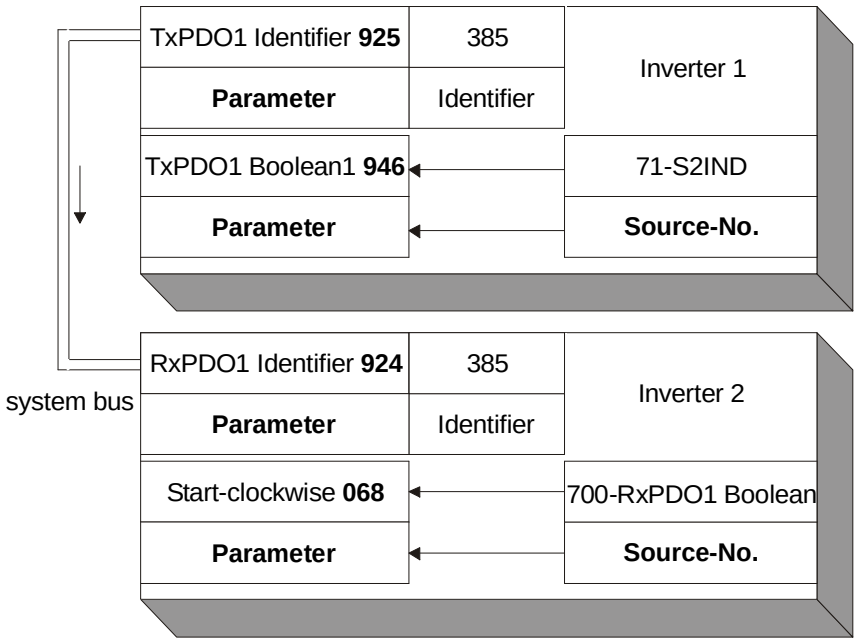
The control word of frequency inverter 1 is linked with the control word of frequency inverter 2. In this way, both frequency inverters can be operated synchronously via the remote control. The output of the reference value channel of frequency inverter 1 is laid onto the output of the ramp of frequency inverter 2. In this way, both frequency inverters have a joint source of reference values and are given reference values in the internal notation.

As an extension, a number of frequency inverters can also exist on the receive side (Rx), these then being supplied with data parallel and simultaneously.

The input link not used in the TxPDO1 of frequency inverter 1 is on ZERO and is thus not served.

Example 2:

Example of a virtual link with transmission via the system bus:



7.12 Control parameters

For the monitoring of the system bus and the display of the internal states, two control parameters are provided. There is a report of the system bus state and a report of the CAN state via two actual value parameters.

The *Node State* **978** parameter gives information about the Pre-Operational, Operational, Stopped state. A PDO transfer is only possible in the Operational state. The state is controlled by the system bus master (PLC / PC / frequency inverter) via NMT telegrams.

The *CAN-State* **979** parameter gives information about the state of the physical layer. If there are transmission errors, the state changes from OKAY to WARNING until the cancellation of the communication with BUS-OFF. After BUS-OFF, the CAN controller is automatically re-initialized and the system bus started again.

Note: If the BUS-OFF state occurs, the frequency inverter breaks down with "**F2210 BUS-OFF**".

After Bus-OFF, the system bus in the frequency inverter is completely reinitialized. There is a new boot-up message from the subscriber and an emergency telegram with the Bus-OFF message is transmitted. The change of state of the subscriber to Operational is done by the Start-Remote-Node telegram cyclically sent by the system bus master.

Actual values of the system bus		
No.	**Description**	**Display**
978	Node state	1 - Pre-Operational 2 - Operational 3 - Stopped
979	CAN state	1 - OKAY 2 - WARNING 3 - BUS-OFF

7.13 Handling of the parameters of the system bus

As soon as the system bus extension module EM-SYS exists in a frequency inverter, the actual value parameters for system state and bus state are activated and can be observed in the actual value menu **VAL** of the control unit KP500 or with the VPlus PC program in the menu **Actual values \ System bus**.

Note: The actual value parameters are on operation level 3 and are thus available for the user at any time.

All the setting parameters for the configuration of the system bus are not directly accessible for the user. For defined customer applications, pre-defined XPI files can be generated by VECTRON for the VPlus PC program, with which the necessary parameters are visible for the user. The application-relevant variables are then available in these XPI files.

Note: XPI files can be read in addition to the loaded parameter information of the frequency inverter into the VPlus PC program.
In the menu of the software under the point "Edit" you find the command "Read in XPI file".

The method of working via an XPI file has its reasoning in the fact that deep interventions in the system are possible via the system bus and can lead to serious problems in the application with an untrained user. Via the XPI files, a user is given a selection list pre-defined by VECTRON.

Attention: The configuration of the necessary parameters for the system bus is accessible by a XPI file with the help of the VPlus PC program.
The control unit KP500 does not support this functionality.
If the extension module system bus EM-SYS is installed additionally to a communication module for the field bus connection (CM-232, CM-485 or CM-PDP) in the frequency inverter, the parameterization can be made with the interface adapter KP232.

Experienced users have complete access to all the existing sources and possible input links with the XPI file of the active functions. The selection depends on the selected configuration and control procedure.

The display of the parameters when using the XPI file is according to the following structure:

System bus

Basic Settings	900	Node-ID
	903	Baud rate
Master Functions	904	Boot-up delay
	919	SYNC-Time
SYNC identifier	918	SYNC identifier
SDO1-Identifier	921	RxSDO1 identifier
	922	TxSDO1 identifier
SDO2 Set Active	923	SDO2 Set Active
PDO Identifier	924	RxPDO1 identifier
	925	TxPDO1 identifier
	926	RxPDO2 identifier
	927	TxPDO2 identifier
	928	RxPDO3 identifier
	929	TxPDO3 identifier
TxPDO Function	930	TxPDO1 Function
	931	TxPDO1 Time
	932	TxPDO2 Function
	933	TxPDO2 Tome
	934	TxPDO3 Function
	935	TxPDO3 Time
RxPDO Function	936	RxPDO1 Function
	937	RxPDO2 Function
	938	RxPDO3 Function
Timeout	939	SYNC timeout
	941	RxPDO1 Timeout
	942	RxPDO2 Timeout
	945	RxPDO3 Timeout
TxPDO1 Objects	946	TxPDO1 Boolean1
	947	TxPDO1 Boolean2
	948	TxPDO1 Boolean3
	949	TxPDO1 Boolean4
	950	TxPDO1 Word1
	951	TxPDO1 Word2
	952	TxPDO1 Word3
	953	TxPDO1 Word4
	954	TxPDO1 Long1
	955	TxPDO1 Long2
TxPDO2 Objects	956	TxPDO2 Boolean1
	957	TxPDO2 Boolean2
	958	TxPDO2 Boolean3
	959	TxPDO2 Boolean4
	960	TxPDO2 Word1
	961	TxPDO2 Word2
	962	TxPDO2 Word3
	963	TxPDO2 Word4
	964	TxPDO2 Long1
	965	TxPDO2 Long2
TxPDO3 Objects	966	TxPDO3 Boolean1
	967	TxPDO3 Boolean2
	968	TxPDO3 Boolean3
	969	TxPDO3 Boolean4
	972	TxPDO3 Word1
	973	TxPDO3 Word2
	974	TxPDO3 Word3
	975	TxPDO3 Word4
	976	TxPDO3 Long1
	977	TxPDO3 Long2

Actual values

System bus	978	Node state
	979	CAN state

7.14 Ancillaries

For the planning of the system bus according to the drive tasks in question, there are ancillaries in the form of tables.

The planning of the system bus is done in three steps:

1. Definition of the communication relationships
2. Production of the virtual links
3. Capacity planning of the system bus

The priority assignment of the identifiers is relevant for the definition of the communication relationships. Data that are to be transmitted with a higher priority must be given low identifiers. This results in the message with the higher priority being transmitted first with a simultaneous access of two subscribers to the bus.

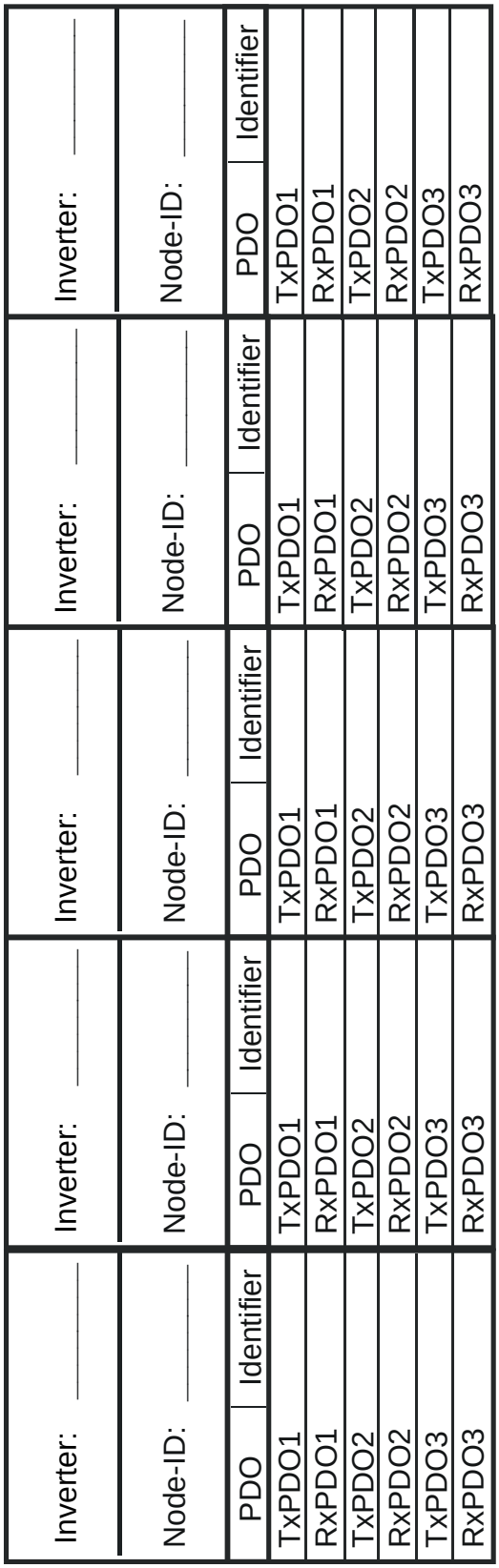
Note: The recommended identifier range for the communication relationships via the PDO channels is 385 ...

The identifiers below 385 are used for the NMT telegrams (boot-up sequence, SYNC telegram) and emergency message.

The identifiers above 1407 are used for the SDO channel for parameterization.

7.14.1 Definition of the communication relationships

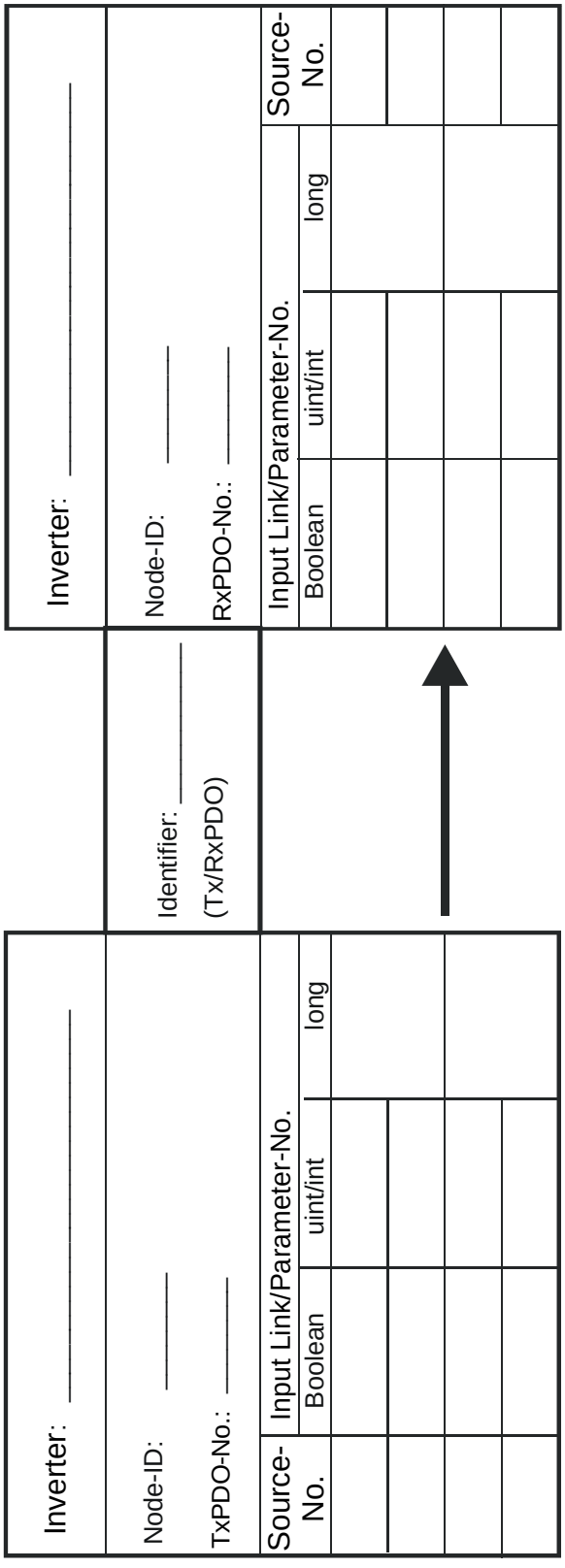
The communication relationships are planned and documented with the help of the table. The table is available as a Microsoft Word document "kbl.doc" on the VECTRON product CD or upon request.



Inverter: _____		Inverter: _____		Inverter: _____		Inverter: _____		Inverter: _____	
Node-ID: _____		Node-ID: _____		Node-ID: _____		Node-ID: _____		Node-ID: _____	
PDO	Identifier	PDO	Identifier	PDO	Identifier	PDO	Identifier	PDO	Identifier
TxPDO1		TxPDO1		TxPDO1		TxPDO1		TxPDO1	
RxPDO1		RxPDO1		RxPDO1		RxPDO1		RxPDO1	
TxPDO2		TxPDO2		TxPDO2		TxPDO2		TxPDO2	
RxPDO2		RxPDO2		RxPDO2		RxPDO2		RxPDO2	
TxPDO3		TxPDO3		TxPDO3		TxPDO3		TxPDO3	
RxPDO3		RxPDO3		RxPDO3		RxPDO3		RxPDO3	

7.14.2 Production of the virtual links

The virtual links are planned and documented with the help of the table. The table is available as a Microsoft Word document "vvk.doc" on the VECTRON product CD or upon request.



7.14.3 Capacity planning of the system bus

Each PDO telegram possesses a constant useful data content of 8 Bytes. According to worst case, this results in a maximum telegram length of 140 bits. The maximum telegram run time of the PDOs is thus stipulated via the set baud rate.

Capacity planning	
Baud rate kBaud	**Telegram runtime µs**
1000	140
500	280
250	560
125	1120
100	1400
50	2800

As a function of the set baud rate and the transmission interval of the TxPDOs selected, the following bus loads results:

Capacity of the system bus										
Baud rate / kBaud	**Bus load as a function of the transmission for one TxPDO in %**									
	1ms	**2ms**	**3ms**	**4ms**	**5ms**	**6ms**	**7ms**	**8ms**	**9ms**	**10ms**
1.000	14	7	4,7	3,5	2,8	2,3	2	1,8	1,6	1,4
500	28	14	9,3	7	5,6	4,7	4	3,5	3,1	2,8
250	56	28	18,7	14	11,2	9,3	8	7	6,2	5,6
125	112	56	37,3	28	22,4	18,7	16	14	12,4	11,2
100	140	70	46,7	35	28	23,3	20	17,5	15,6	14
50	280	140	93,3	70	56	46,7	40	35	31,1	28

Attention: A bus load >100% means that a telegram cannot be dispatched completely between two transmission times.

Such a setting is not admissible!

This observation must be done for each TxPDO. The sum of all the TxPDOs decides on the entire bus load. The bus load must be designed in such a way that any telegram repetitions for transmission errors are possible without exceeding the bus capacity.

Note: To facilitate capacity planning, a Microsoft Excel file with the name "Load_Systembus.xls" is available.

The capacity planning are planned and documented with the help of the table. The work sheet is available as a Microsoft Excel document "Load_Systembus.xls" on the VECTRON product CD or by request.

Load system bus	
Baud rate [kBaud]: 50, 100, 125, 250, 500, 1000	**1000**

Frequency inverter	TxPDO Number	Ta [ms]	Workload [%]
1	1	0	0
	2	0	0
	3	0	0
2	1	0	0
	2	0	0
	3	0	0
3	1	0	0
	2	0	0
	3	0	0
4	1	0	0
	2	0	0
	3	0	0
5	1	0	0
	2	0	0
	3	0	0
6	1	0	0
	2	0	0
	3	0	0
7	1	0	0
	2	0	0
	3	0	0
8	1	1	14
	2	1	14
	3	1	14
9	1	1	14
	2	1	14
	3	0	0
10	1	0	0
	2	0	0
	3	0	0
Total workload [%]			**70**

In the table, the set baud rate is entered from the parameter *Baud Rate* **903**in kBaud. For each frequency inverter, the set time for the transmission interval (e. g. *TxPDO1 Time* **931**) in ms is entered for the TxPDO being used at the time. In the column **Load** the bus load caused by the individual TxPDO appears, under **Total Load** the entire bus load.

For the bus load (Total load) the following limits have been defined:

≤ **80 %** ➔ **OKAY**
80 ... 90 % ➔ **CRITICAL**
> 90 % ➔ **NOT POSSIBLE**

8 Control inputs and outputs

8.1 Analog input EM S1INA

8.1.1 General

The analog input of the EM-ABS-01 extension module can be used as a voltage input. Parameterization of the input signal is done via the definition of a linear characteristic and assignment as

- Reference value source
  (selectable via parameter *Reference frequency source* **475**),
- Reference percentage source
  (selectable via parameter *Reference percentage source* **476**),
- Actual percentage source
  (selectable via parameter *Actual percentage source* **478**, in configuration **x11**)
  or
- limit value sources
  (can be selected via the parameters **734** … **737**).

8.1.2 Characteristic

Mapping of the analog input signal onto a reference frequency value or a reference percentage value is possible for various requirements. Parameterization is to be done via two points of the linear characteristic of the reference value channel.
The characteristic point 1, with the coordinates X1 and Y1, and the characteristic point 2, with the coordinates X2 and Y2, can be set in four parameters.
Points X1 and X2 are stated in per cent, as the analog input can be switched as a current or voltage input via switch S3.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
564	Point X1	-100,00 %	100,00 %	-98,00 %
565	Point Y1	-100,00 %	100,00 %	-100,00 %
566	Point X2	-100,00 %	100,00 %	98,00 %
567	Point Y2	-100,00 %	100,00 %	100,00 %

The coordinates of the points relate, as a percentage, to the analog signal with 10 V or 20 mA and parameter *Maximum Frequency* **419** or parameter *Maximum Reference Percentage* **519**. The direction of rotation can be changed via the digital inputs of the frequency inverter and/or by selection of the points.

The definition of the analog input characteristic can be calculated via the two-point form of the line equation. The speed Y of the drive is controlled ac-cording to the analog control signal X.

$$Y = \frac{Y2 - Y1}{X2 - X1} \cdot (X - X1) + Y1$$

Attention! The monitoring of the analog input signal via parameter *Error/Warning behavior* **563** demands examination of the characteristic parameters. Sensible use is only possible if *Point X1* **564** is in the positive range.

8.1.3 Operation modes

The operation modes of the analog input characteristic enable application-related scaling as a supplement to the characteristic points mentioned above. One of the four linear types of characteristic is selected for the signal adaptation for the analog input signal via parameter *Operation mode* **562**. If the points are not suited for the type of characteristic selected, they are corrected internally.

Operation mode 562	Function
1 - bipolar	The analog input signal is mapped onto the reference value according to the points (X1/Y1) and (X2/Y2).
11 - unipolar	With a negative parameter value of the points X1 or X2, the latter are mapped to the reference value zero.
21 - unipolar 2-10V/4-20mA	If the points X1 or X2 have been set with a negative parameter value or less than 0%, the input characteristic is mapped to the reference value 20%.
101 - bipolar abs.	Negative parameter values of the points Y1 or Y2 are mapped as a positive reference value in the characteristic.

Further information on the operation modes stated in the table can be found in the following chapter "Examples".

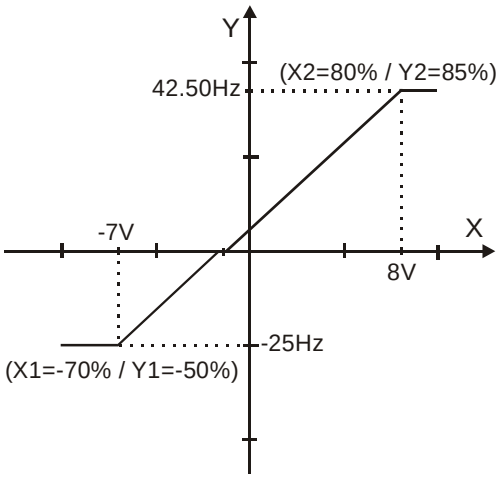
8.1.3.1 Examples

The analog input signal is mapped onto a reference value as a function of the characteristic selected. The following examples show the operation modes for an analog voltage signal. The parameter *Minimum Frequency* **418** has been set to the value 0.00 Hz. The characteristic point 100% for the Y axis corresponds to the parameter *Maximum Frequency* **419** of 50.00 Hz in the examples.

Attention! The various operation modes change the input characteristic as a func-tion of the characteristic points parameterized. In the following examples, the areas of the system of coordinates from which a characteristic point is displaced are marked.

Operation mode "1 – bipolar"

In operation mode "1 – bipolar", the characteristic of the analog input can be freely set by stating two characteristic points.



Point 1:
X1 = -70.00% · 10 V = -7.00 V
Y1 = -50.00% · 50.00 Hz = -25.00 Hz

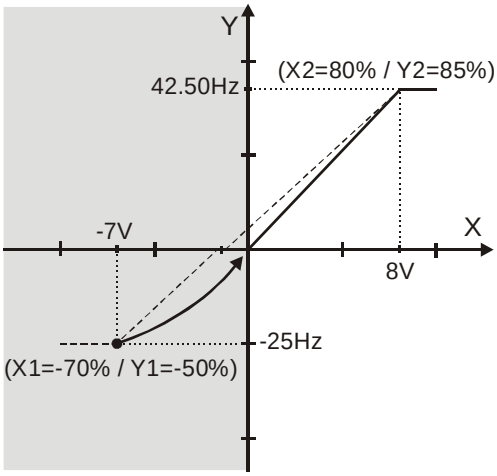
Point 2:
X2 = 80.00% · 10 V = 8.00 V
Y2 = 85.00% · 50.00 Hz = 42.50 Hz

Tolerance band:
ΔX = 2.00% · 10 V = 0.20 V

The direction of rotation is changed in this example at an analog input signal of -1.44 V, with a tolerance band of ±0.20 V.

Operation mode "11 – unipolar"

In operation mode "11 – unipolar", the characteristic points are displaced to the origin of the characteristics with a negative value for the X axis.

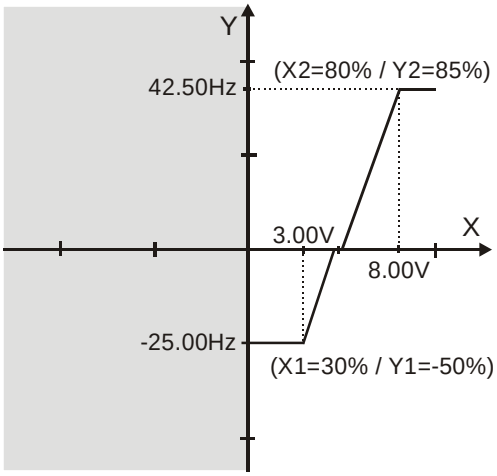


Point 1:
X1 = -70.00% · 10 V = -7.00 V
Y1 = -50.00% · 50.00 Hz = -25.00 Hz

Point 2:
X2 = 80.00% · 10 V = 8.00 V
Y2 = 85.00% · 50.00 Hz = 42.50 Hz

Tolerance band:
ΔX = 2.00% · 10 V = 0.20 V

Point 1 has been shifted into the origin. The parameter *Tolerance band* **560** is not taken into account in this example, as no change of sign of the reference frequency value takes place.



Point 1:
X1 = 30.00 % · 10 V = 3.00 V
Y1 = -50.00 % · 50.00 Hz = -25.00 Hz

Point 2:
X2 = 80.00 % · 10 V = 8.00 V
Y2 = 85.00 % · 50.00 Hz = 42.50 Hz

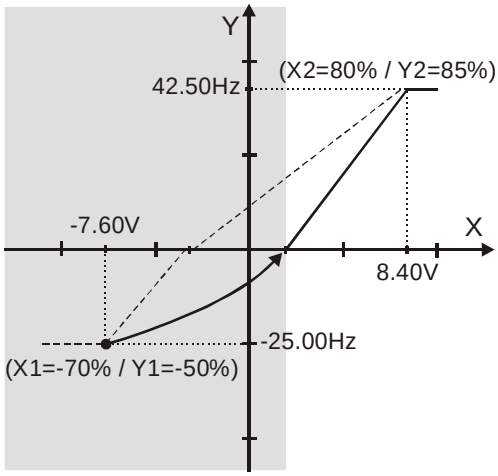
Tolerance band:
ΔX = 2.00 % · 10 V = 0.20 V

The direction of rotation is changed in this example at an analog input signal of 4.85 V, with a tolerance band of ±0.20 V.

Operation mode "21 – unipolar 2-10V/4-20mA"

This operation mode limits the input characteristic to the area between 20% and 100% of the analog signal. If the value for a characteristic point of the X axis is outside 0%, it is mapped to the characteristic point (2 V / 0 Hz).
The characteristic point on the X axis is calculated according to the following formula:

$$\text{Kennlinienpunkt X} = \text{Parameterwert X} \cdot (100{,}00\% - 20{,}00\%) + 20{,}00\%$$

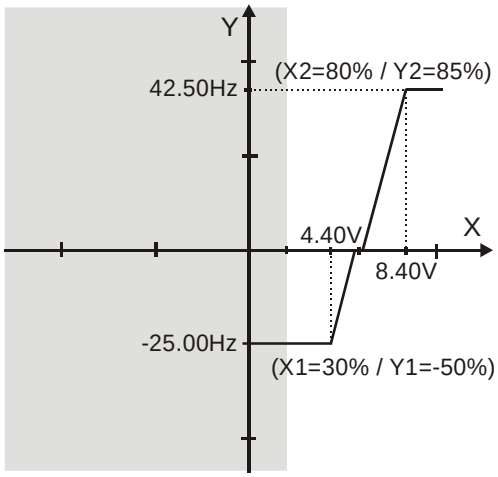


Point 1:
X1 = [-70.00% · (100.00% - 20.00%) + 20.00%] · 10 V = -7.60 V
Y1 = -50.00% · 50.00 Hz = -25.00 Hz

Point 2:
X2 = [80.00% · (100.00% - 20.00%) + 20.00%] · 10 V = 8.40 V
Y2 = 85.00% · 50.00 Hz = 42.50 Hz

Tolerance band:
ΔX = [2.00% · (100.00% - 20.00%) · 10 V] = 0.16 V

The characteristic point 1 has been displaced to the point (2.00V / 0.00 Hz). The parameter *Tolerance band* **560** is not taken into account in this example, as no change of sign of the reference frequency value takes place.



Point 1:
X1 = [30.00% · (100.00% - 20.00%) + 20.00%] · 10 V = 4.40 V
Y1 = -50.00% · 50.00 Hz = -25.00 Hz

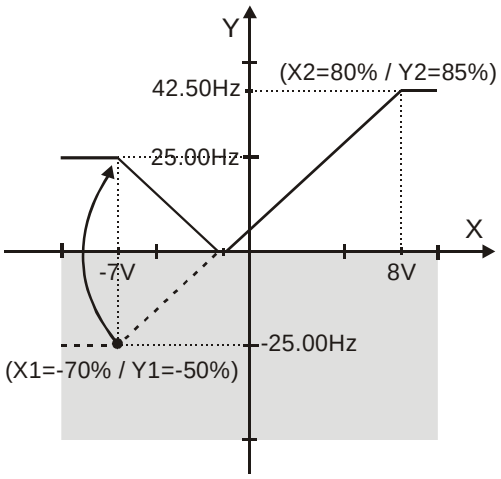
Point 2:
X2 = [80.00% · (100.00% - 20.00%) + 20.00%] · 10 V = 8.40 V
Y2 = 85.00% · 50.00 Hz = 42.50 Hz

Tolerance band:
ΔX = [2.00% · (100.00% - 20.00%) · 10 V] = 0.16 V

The direction of rotation is changed in this example at an analog input signal of 5.88 V, with a tolerance band of ±0.16 V.

Operation mode "101 – bipolar Amount"

The operation mode "101 – bipolar Amount" maps the bipolar analog signal onto a unipolar input characteristic. The formation of the absolute amount takes the characteristic into account comparable to the "bipolar" operation mode, but the characteristic points are reflected on the X axis with a negative value for the Y axis.



Point 1:
X1 = -70.00% · 10 V = -7.00 V
Y1 = -50.00% · 50.00 Hz = -25.00 Hz

Point 2:
X2 = 80.00% · 10 V = 8.00 V
Y2 = 85.00% · 50.00 Hz = 42.50 Hz

Tolerance band:
ΔX = 2.00% · 10 V = 0.20 V

In this example, the reference value is again increased from an analog input signal of -1.44 V with a tolerance band of ±0.20 V. The theoretical change of sign of the reference value is taken into account and leads to the tolerance band stated. There is no change of the direction of rotation.

8.1.4 Scaling

The analog input signal is mapped to the freely configurable characteristic. The maximum admissible setting range of the drive mechanism is to be set via the frequency limits or percentage limits according to the configuration selected. In parameterization of a bipolar characteristic, the minimum and maximum limits for both directions of rotation are taken on. The percentage values of the points relate to the maximum limits selected.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
418	Minimum frequency	0.00 Hz	999.99 Hz	3.50 Hz
419	Maximum frequency	0.00 Hz	999.99 Hz	50.00 Hz

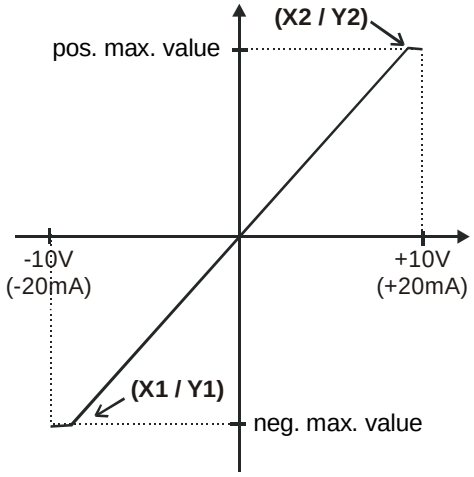
The control system uses the maximum value of the output frequency, which is calculated from the *Maximum Frequency* **419** and the compensated slip of the drive mechanism. The frequency limits define the speed range of the drive, and the percentage values supplement the scaling of the analog input characteristic in accordance with the functions configured.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
518	Minimum percentage	0,00%	300,00%	0,00%
519	Maximum percentage	0,00%	300,00%	100,00%

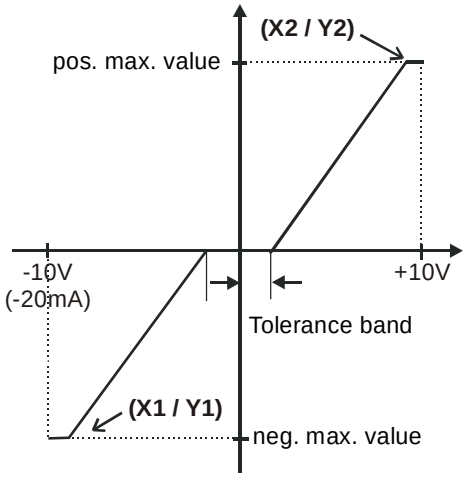
8.1.5 Tolerance Band and Hysteresis

The analog input characteristic with change of sign of the reference value can be adapted by the parameter *Tolerance band* **560** of the application. The tolerance band to be defined extends the zero crossing of the speed relative to the analog control signal. The parameter value (percent) is relative to the maximum current or voltage signal.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
560	Tolerance band	0,00%	25,00%	2,00%

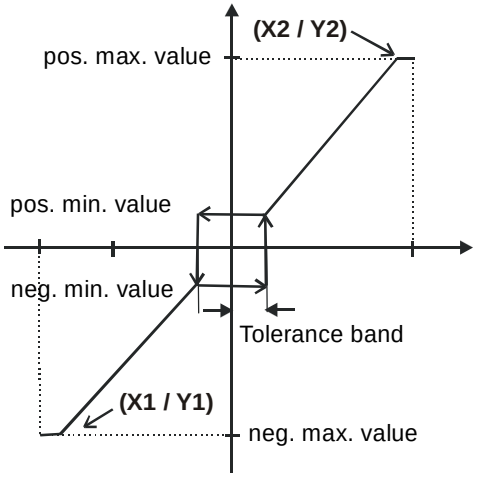


Without tolerance band



With tolerance band

The default *Minimum Frequency* **418** or *Minimum Percentage* **518** extends the parameterized tolerance band to the hysteresis.



With tolerance band and minimum value

For example, the output variable coming from positive input signals is kept on the positive minimum value until the input signal becomes lower than the value for the tolerance band in the negative direction. Then, the output variable follows the set characteristic.

8.1.6 Error and warning behavior

The monitoring of the analog input signal necessary according to the application is configured via the parameter *Error/Warning Behavior* **563** .

Error/warning behavior **563**	Function
0 - Off	The input signal is not monitored.
1 - Warning < 1V/2mA	If the input signal is lower than 1 V, a warning message is issued.
2 - Shut Down < 1V/2mA	If the input signal is lower than 1 V, a warning message is issued; the drive is decelerated according to stopping behavior 1.
3 - Error switch-off < 1V/2mA	If the input signal is smaller than 1 V, there is a warning and fault message and the drive mechanism stops freely.

Monitoring of the analog input signal is active regardless of the release of the fre-quency inverter according to the operation mode selected.

In operation mode **2**, the drive mechanism is decelerated according to stopping behavior 1 (stop and shutdown) regardless of the stopping behavior selected (Parameter *Operation mode* **630**). If the set holding time has expired, an error message is issued. Repeat starting of the drive mechanism is possible by switching the start signal on and off if the error has already been corrected.

Operation mode **3** defines free coasting of the drive, regardless of the stopping behavior selected defined in parameter *Stopping behavior* **630**.

Attention! The monitoring of the analog input signal via parameter *Error/Warning behavior* **563** demands examination of the characteristic parameters.

8.1.7 Adjustment

Due to component tolerance, it can be necessary to adjust the analog input. This is done via parameter *Adjustment* **568**.

Adjustment 568	Function
0 - No adjustment	Standard operation
1 - Adjustment 0 V	Adjustment of the measurement with an analog signal of 0 V.
2 - Adjustment 10 V	Adjustment of the measurement with an analog signal of 10 V.

Example of the adjustment of an analog input with a voltage signal:

Note: The measurements for the adjustment are to be done with a suitable measuring instrument and the correct polarity.
If not, faulty measurements can result.

- Apply 0 V to the analog input; e.g. with a bridge from the terminal of the analog input X410A.6 to terminal X210B.7 (earth/GND) of the frequency inverter.
- Select operation mode "1 - Adjustment 0 V".
- Apply 10 V to the analog input, e.g. with a bridge from the terminal of the analog input to terminal X210B.5 (reference output 10 V) of the frequency inverter.
- Select operation mode "2 - Adjustment 10 V". This completes the adjustment of the analog input.

8.1.8 Filter time constant

The time constant of the filter for the reference analog value can be set via the parameter *Filter time constant* **561**.
The time constant indicates the time during which the input signal is averaged by means of a low pass filter, e.g. in order to eliminate fault effects.
The setting range is between 0 ms and 5000 ms in 15 steps.

Filter time constant 561	Function
0 - Time constant 0 ms	Filter deactivated – analog reference value is forwarded unfiltered
2 - Time constant 2 ms	Filter activated – averaging of the input signal via the set value of the filter time constants Factory setting: 8 ms.
4 - Time constant 4 ms	
8 - Time constant 8 ms	
16 - Time constant 16 ms	
32 - Time constant 32 ms	
64 - Time constant 64 ms	
128 - Time constant 128 ms	
256 - Time constant 256 ms	
512 - Time constant 512 ms	
1000 - Time constant 1000 ms	
2000 - Time constant 2000 ms	
3000 - Time constant 3000 ms	
4000 - Time constant 4000 ms	
5000 - Time constant 5000 ms	

8.2 Digital outputs EM-S1OUTD and EM-S2OUTD

8.2.1 General

Parameterization of the digital outputs permits a linking to a variety of functions. The selection of the functions depends on the parameterized configuration.

8.2.2 Operation modes

The operation mode of digital output EM-S1OUTD (Terminal X410A.3) is done via parameter *Operation mode EM-S1OUTD* **533**. By default, this parameter is set to "41 - Open brake".

The operation mode of digital output EM-S1OUTD (Terminal X410A.4) is done via parameter *Operation mode EM-S2OUTD* **534**. By default, this parameter is set to "0 - Off".

The operation modes to be selected correspond to the table shown in the operating instructions of the frequency inverter in the chapter "Digital outputs".

8.2.3 Repetition frequency output via EM-S1OUTD and EM-S2OUTD

Digital outputs EM-S1OUTD and EM-S2OUTD can be used as repetition frequency outputs. The output value of the repetition frequency output corresponds to the mechanical frequency of the connected encoder.

Digital outputs EM-S1OUTD and EM-S2OUTD can be set up as a repetition frequency output via parameter *Repetition frequency EM-S1/2OUTD* **509**.

Repetition frequency EM-S1/2OUTD **509**	Function
0 - Off	Reference frequency output is turned off. Factory setting.
1 - On	The repetition frequency output via digital outputs EM-S1OUTD and EM-S2OUTD is turned on. The number of division marks of the repetition frequency output corresponds to the number of encoder division marks (set via *Division marks* **1183**, see chapter 8.4.1).

8.3 Digital inputs EM-SxIND

The EM-ABS-01 extension module has three digital inputs. The assignment of the control signals to the available software functions can be adapted to the application in question. Depending on the *Configuration* **30** selected, the default assignment or the selection of the operation mode differ. In addition to the available digital control inputs, further internal logic signals are available as sources.

The individual software functions are assigned to the various signal sources via parameterizable inputs. This enables a flexible use of the digital control signals.

Operation mode	Function
320 - EM-S1IND	Signal on digital input 1 (X410B.2)
321 - EM-S2IND	Signal on digital input 2 (X410B.3)
322 - EM-S3IND	Signal on digital input 3 (X410B.4)
520 - EM-S1IND inverted	Inverted signal on digital input 1 (X410B.2)
521 - EM-S2IND inverted	Inverted signal on digital input 2 (X410B.3)
522 - EM-S3IND inverted	Inverted signal on digital input 3 (X410B.4)

Alongside the operation modes listed, those stated in the operating instructions of the frequency inverter in the chapter "Digital inputs" also apply.

8.3.1 Fixed reference value and fixed value change-over

Depending on the *Reference Frequency Source* **475** selected, fixed frequencies can be used as reference values. The module extends the functionality described in the frequency inverter user manual (Parameters *Fixed frequency change-over 1* **66** and *Fixed frequency change-over 2* **67**) by parameter *Fixed frequency change-over 3* **131** and the corresponding parameters *Fixed frequency 5* **485**, *Fixed frequency 6* **486**, *Fixed frequency 7* **487**, *Fixed frequency 8* **488**.

	Fixed frequency change-over 1 **66**	*Fixed frequency change-over 2* **67**	*Fixed frequency change-over 3* **131**
Fixed frequency 1 **480**	0	0	0
Fixed frequency 2 **481**	1	0	0
Fixed frequency 3 **482**	1	1	0
Fixed frequency 4 **483**	0	1	0
Fixed frequency 5 **485**	0	1	1
Fixed frequency 6 **486**	1	1	1
Fixed frequency 7 **487**	1	0	1
Fixed frequency 8 **488**	0	0	1

8.4 Encoder input EM-ABS-01

The encoder input is used for evaluating the position information from the encoder. Depending on the encoder system used, certain parameters need to be set up. The following table describes the use of the individual parameters for the encoder systems.

Parameters		Encoder system			
No.	**Description**	**SinCos**	**Hiperface**	**EnDat 2.1**	**SSI**
513	EC2 Gear Factor Numerator	X	X	X	X
514	EC2 Gear Factor Denominator	X	X	X	X
1183	Division marks	X	X	X	(X)
1184	Encoder signals/log	X	X	X	X
1186	Power supply	X	X	X	X
1187	Supply voltage	X	X	X	X
1188	Offset	1)			
1268	SSI: Sampling interval	---	---	---	X
1269	SSI: Error-/Extra-Bits (Low)	---	---	---	X
1270	SSI: Error-/Extra-Bits (High)	---	---	---	X
1271	Bits/Turn	---	X	---	X
1272	Bits Multiturn	---	X	---	X

X: Parameter must be configured according to the encoder data sheet.
--- Parameter has no function for this encoder type.
(X): In the case of SSI encoders the evaluation of the division marks depends on the setting of *Tracks/Protocol* **1184**.
1): Setting the offset is required in the case of synchronous motors.

In addition, the following actual value parameters are available:

Parameters		Encoder system			
No.	**Description**	**SinCos**	**Hiperface**	**EnDat 2.1**	**SSI**
1267	Abs. encoder raw data	---	X	X	X
1274	Warning Dig. Encoder	---	---	X	---

Note: If positioning (configurations x40) is used, please note to the instructions in chapter 8.4.11.1.

Note: Gear factors *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514** are not available in configurations 5xx.

8.4.1 Division marks

In parameter *Division marks* **1183**, you can set the type-specific number of division marks of the encoder. The number of division marks is typically described in amplitudes/revolution in the case of encoders with SinCos tracks. Enter the division marks or amplitudes/revolution in parameter *Division marks* **1183**.

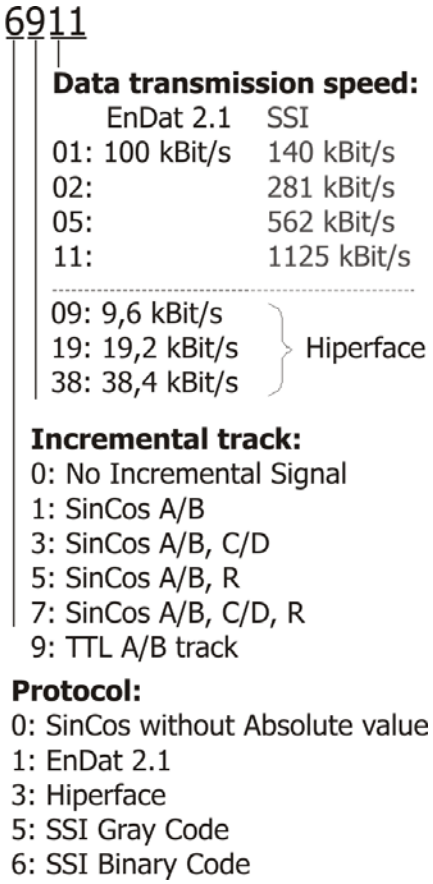
Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1183	Division marks	0	8192	1024

Note: In the case of SSI absolute value encoders, evaluation of *Division marks* **1183** is active only if *Tracks/Protocol* **1184** is described in an operation mode for evaluation of TTL [RS-422] or SinCos tracks (settings 51xx, 59xx, 61xx and 69xx).

8.4.2 Tracks/Protocol

Via parameter *Tracks/Protocol* **1184**, you can specify the type-specific number of analog Tracks/Protocol of the encoder and evaluation of a reference track.

Key of Tracks/Protocol:



Note: The identifiers of track A/B and Sin/Cos are typically ambivalent and can be set to A = Sin and B = Cos.

	Tracks/Protocol **1184**	Function
	0 - off	Evaluation is turned off. **Factory setting**.
SinCos	100 - A/B	Evaluation of analog Tracks/Protocol A and B.
	300 - A/B, C/D	Evaluation of analog Tracks/Protocol A and B and commutation Tracks/Protocol C and D.
	500 - A/B, R	Evaluation of analog Tracks/Protocol A and B as well as reference track R. Monitoring and comparison of Tracks/Protocol.
	700 - A/B, C/D, R	Evaluation of analog Tracks/Protocol A and B and commutation Tracks/Protocol C/E as well as reference track R. Monitoring and comparison of Tracks/Protocol.
EnDat 2.1	1101 EnDat 2.1	Evaluation of analog Tracks/Protocol A/B and the data and clock track with the EnDat 2.1 protocol. Monitoring and comparison of Tracks/Protocol.
Hiperface	3109 Hiperface, 9.6 kBit/s	Evaluation of analog Tracks/Protocol A/B and the data tracks with the Hiperface protocol. Monitoring and comparison of Tracks/Protocol. The data track is transmitted at 9.6 kBaud.
	3119 Hiperface, 19.2 kBit/s	Like 3109. The data track is transmitted at 19.2 kBaud.
	3138 Hiperface, 38.4 kBit/s	Like 3109. The data track is transmitted at 38.4 kBaud.

	Tracks/Protocol 1184	Function
SSI Gray code	5001 SSI, Gray code, 141 kBit/s	Evaluation of data and clock tracks with the SSI protocol (without TTL or SinCos track). The data track is transmitted at 140.625 kBaud in Gray code. **This function is currently being prepared!**
	5002 SSI, Gray code, 281 kBit/s	Like 5001. The data track is transmitted at 281.25 kBaud in Gray code.
	5005 SSI, Gray code, 563 kBit/s	Like 5001. The data track is transmitted at 562.5 kBaud in Gray code.
	5011 SSI, Gray code, 1125 kBit/s	Like 5001. The data track is transmitted at 1125 kBaud in Gray code.
	5101 SSI+SINCOS, Gray code, 141 kBit/s	Evaluation of Tracks/Protocol A/B as SINCOS track and the data and clock tracks with the SSI protocol. The data track is transmitted at 140.625 kBaud in Gray code.
	5102 SSI+SINCOS, Gray code, 281 kBit/s	Like 5101. The data track is transmitted at 281.25 kBaud in Gray code.
	5105 SSI+SINCOS, Gray code, 563 kBit/s	Like 5101. The data track is transmitted at 562.5 kBaud in Gray code.
	5111 SSI+SINCOS, Gray code, 1125 kBit/s	Like 5101. The data track is transmitted at 1125 kBaud in Gray code.
	5901 SSI+TTL, Gray code, 141 kBit/s	Evaluation of Tracks/Protocol A/B as TTL [RS-422] track and the data and clock tracks with the SSI protocol. The data track is transmitted at 140.625 kBaud in Gray code.
	5902 SSI+TTL, Gray code, 281 kBit/s	Like 5901. The data track is transmitted at 281.25 kBaud in Gray code.
	5905 SSI+TTL, Gray code, 563 kBit/s	Like 5901. The data track is transmitted at 562.5 kBaud in Gray code.
	5911 SSI+TTL, Gray code, 1125 kBit/s	Like 5901. The data track is transmitted at 1125 kBaud in Gray code.
SSI Binary code	6001 SSI, binary code, 141 kBit/s	Evaluation of data and clock tracks with the SSI protocol (without TTL or SinCos track). The data track is transmitted at 140.625 kBaud in binary code. **This function is currently being prepared!**
	6002 SSI, binary code, 281 kBit/s	Like 6001. The data track is transmitted at 281.25 kBaud in binary code.
	6005 SSI, binary code, 563 kBit/s	Like 6001. The data track is transmitted at 562.25 kBaud in binary code.
	6011 SSI, binary code, 1125 kBit/s	Like 6001. The data track is transmitted at 1125 kBaud in binary code.
	6101 SSI+SINCOS, binary code, 141 kBit/s	Evaluation of Tracks/Protocol A/B as SINCOS track and the data and clock tracks with the SSI protocol. The data track is transmitted at 140.625 kBaud in binary code.
	6102 SSI+SINCOS, binary code, 281 kBit/s	Like 6101. The data track is transmitted at 281.25 kBaud in binary code.
	6105 SSI+SINCOS, binary code, 563 kBit/s	Like 6101. The data track is transmitted at 562.25 kBaud in binary code.
	6111 SSI+SINCOS, binary code, 1125 kBit/s	Like 6101. The data track is transmitted at 1125 kBaud in binary code.
	6901 SSI+TTL, binary code, 141 kBit/s	Evaluation of Tracks/Protocol A/B as TTL [RS-422] track and the data and clock tracks with the SSI protocol. The data track is transmitted at 140.625 kBaud in binary code.
	6902 SSI+TTL, binary code, 281 kBit/s	Like 6901. The data track is transmitted at 281.25 kBaud in binary code.

Tracks/Protocol **1184**	Function
6905 SSI+TTL, binary code, 563 kBit/s	Like 6901. The data track is transmitted at 562.25 kBaud in binary code.
6911 SSI+TTL, binary code, 1125 kBit/s	Like 6901. The data track is transmitted at 1125 kBaud in binary code.

Note: For synchronous servomotors, an encoder with commutation track or absolute value will be required. Settings 100 and 500 are only intended for operation with asynchronous motors for this reason. In the case of synchronous servomotors, set the *Offset* **1188** according to chapter 8.4.6.

Note: Changeover of parameter *Tracks/Protocol* **1184** can only be done with the output stage disabled. After the parameter change, the new encoder type will have to be initialized. This may take up to 5 seconds.
After mains on, an initialization may have to be performed depending on the encoder type. This may take up to 5 seconds.

Note for SSI encoders: The usable transmission rate depends on the length of the encoder cable. In case there are any transmission errors, reduce the transmission rate.

8.4.3 Power supply

Via parameter *Power supply* **1186**, you can choose the encoder power supply source. Depending on the power demand of the encoder, you can connect an external power supply to terminals X410A.1 and X410A.2 (see Chapter 5.3.3 "Power supply"). In this case, parameter *Power supply* **1186** must be set to "2 – Via X410A" or "6 – Via X410A, Sense".

The operation modes with meas. line "sense" (*Power supply* **1186** = "5 – intern, Sense" or "6 – Via X410A, Sense") enable monitoring of the supply voltage of the encoder. In these settings, deviations will be compensated when the supply voltage of the encoder deviates from the set voltage level. To that end, the voltage is measured at the end of the supply line (at encoder).
In operation modes 1 and 2, the voltage is controlled at the EM-ABS-01 module, power losses during energy transmission via the supply line will not be compensated.

The encoder can be powered as follows:
- via control terminals X410A.5 (5 … 12 VDC) and X410A.7 (GND) or
- via contacts X412.6 (V_{Enc}) and X412.15 (0VL) of the female HD-Sub-D connector.

See chapters 5.3.2 "Control terminals" and 5.3.3 "Power supply".

Caution! Always set the *Supply voltage* **1187** first, then set *Power supply* **1186**. Otherwise, the encoder might be destroyed by high voltage levels.

Power supply **1186**	
0 - off	No power supply selected for the encoder. This setting is also used if the encoder is connected directly to an external power supply. **Factory setting**.
1 - Intern	power supply to encoder – at terminals X410A.5 (5 … 12 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 5 … 12 VDC) and X412.15 (0VL). Voltage source is provided internally by the frequency inverter, max. 2 W.
2 - Via X410A	power supply to encoder – at terminals X410A.5 (5 … 12 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 5 … 12 VDC) and X412.15 (0VL). Power supply is effected through an external power source which must be connected to terminals X410A.1 (24 VDC) and X410A.2 (ground).
5 - intern, Sense	power supply to encoder – at terminals X410A.5 (5 … 12 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 5 … 12 VDC) and X412.15 (0VL). Voltage source is provided internally by the frequency inverter, max. 2 W. A measuring line "sense" of the encoder must be connected in order to monitor the supply voltage.
6 - Via X410A, Sense	power supply to encoder – at terminals X410A.5 (5 … 12 VDC) and X410A.7 (GND) – at contacts X412.6 (V_{Enc}: 5 … 12 VDC) and X412.15 (0VL). Power supply is effected through an external power source which must be connected to terminals X410A.1 (24 VDC) and X410A.2 (ground). A measuring line "sense" of the encoder must be connected in order to monitor the supply voltage.

Note:
Even if the encoder features a measuring line "sense", you can chose operation mode 1 or 2.

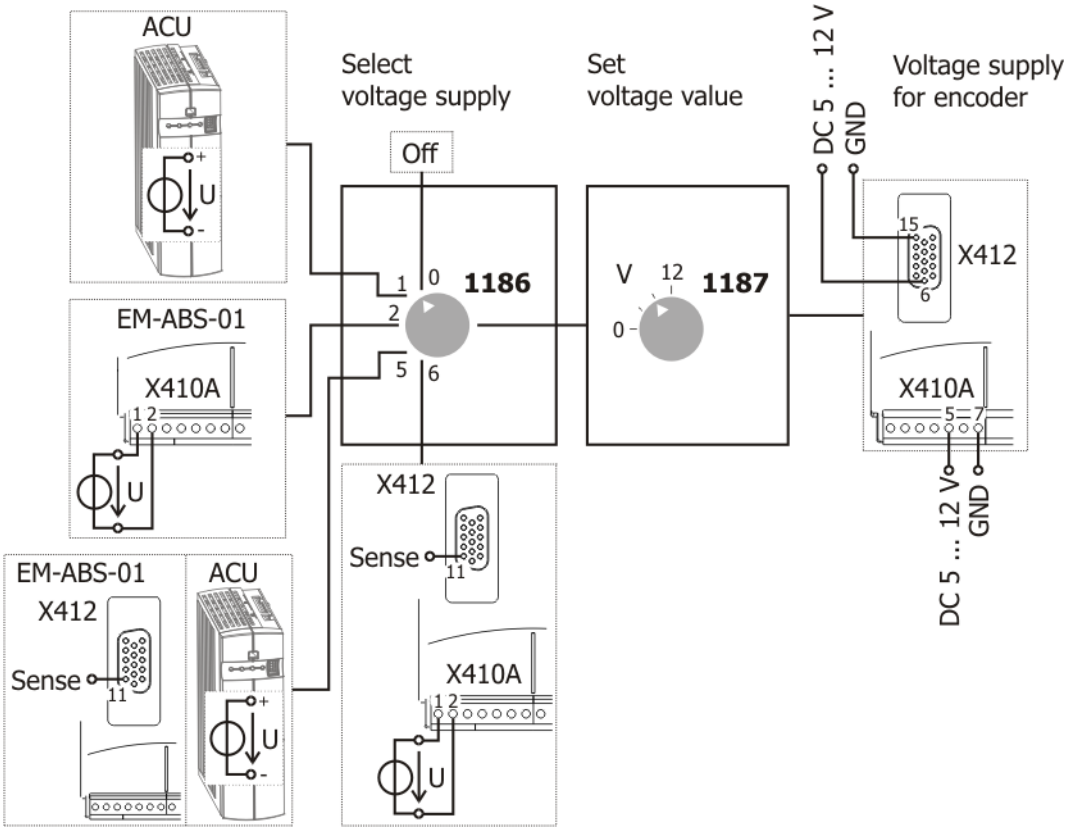
Note:
In the case of Hiperface encoders, the sense line (settings "5-intern, Sense" or "6-Via X410A, sense") is typically not used, as it is not defined in the Hiperface standard Specification. Thus, using the sense line is not required in the case of Hiperface encoders.

Note:
The maximum voltage of the power supply is DC 12 V. Via a sense line, the voltage can be monitored at the encoder, but the voltage output is limited to DC 12 V.

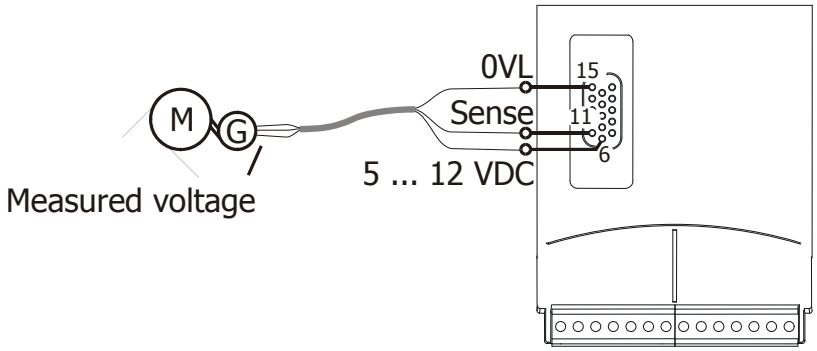
The voltage level can be set up via parameter *Supply voltage* **1187**. See chapter 8.4.4 "Supply voltage".

Note:
BONFIGLIOLI VECTRON recommends connecting an external power supply to the voltage input of the control terminal. This auxiliary voltage enables powering an encoder via the voltage output of the control terminal. Refer to the encoder manufacturer's power specifications.

Choosing the source for encoder power supply and setting the voltage level



Measuring line “sense”: constant voltage level at encoder



G: encoder

The encoder supply voltage is measured at the SinCos encoder and kept constant at the adjusted value of *Supply voltage* **1187** (DC 5 … 12 V).

8.4.4 Supply voltage

Via parameter *Supply voltage* **1187**, you can select the voltage level for encoder power supply.
The SinCos encoder can be powered as follows:

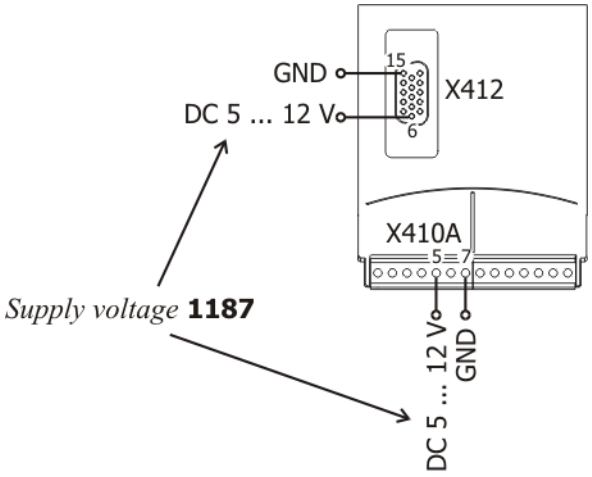
- via control terminals X410A.5 (5 … 12 VDC) and X410A.7 (GND) or
- via contacts X412.6 (V_{Enc}) and X412.15 (0VL) of the female HD-Sub-D connector.

The parameter setting is effective on the terminals and the contact of the female HD-Sub-D connector.

Caution! Note the encoder manufacturer's supply voltage specifications. Non-compliance may damage the encoder.

Caution! Always set the *Supply voltage* **1187** first and then set *Power supply* **1186**. Otherwise, the encoder might be destroyed by high voltage levels.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1187	Supply voltage	5.0 V	12.0 V	5.0 V



8.4.5 Speed filter

Via parameter *Abs. Encoder: Filter time constant* **1189**, you can filter high frequency of the encoder signals and limit the control band width.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1189	Abs. Encoder: Filter time constant	125 µs	8000 µs	125 µs

8.4.6 Offset

In order to enable the start of a synchronous machine, the absolute position of the rotor must be known. This information is required in order to actuate the stator windings in the right order depending on the position of the rotor. The position of the rotary field in the synchronous machine must be controlled in order to obtain a continuous movement of the rotor. During first commissioning, the position of the rotor winding of the encoder is adjusted to the rotor displacement angle of the synchronous motor by adjusting the offset. For operating a synchronous machine with encoder, the offset must be adjusted in order to obtain perfectly true running and a maximum torque.
The correct *Offset* **1188** is adjusted when the *Flux-forming voltage* **235** is roughly the same in both directions when the motor is turning and comes as close as possible to the value 0. Also note the fine setup instructions at the end of this chapter.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1188	Offset	-360,0°	360,0°	0,0°

The offset can be determined and adjusted as follows:

- During first commissioning "SEtUP" will be displayed in the control unit. Press ESC to stop this operation. The guided commissioning ("SETUP") is performed after adjusting the offset.
- Open the parameter menu "PARA" and enter the machine data indicated on the type plate or the data sheet of the motor.

Before adjusting the offset, take the following **safety precautions**:

- Turn of release of the frequency inverter via the digital inputs for controller release.
- If possible, uncouple the motor from the load so that the motor shaft turns freely. If installed, release the mechanical brake.

If uncoupling is not possible, make sure that the motor is loaded as little as possible.

Warning! In certain circumstances, the motor speed may reach high values. If the motor is not uncoupled from the load, personal and material damage may result. To avoid such damage, make the following settings in any case.

- Set the max. permissible output frequency of the frequency inverter to a low frequency value via parameter *Shutdown limit frequency* **417**. Select the frequency value such that uncontrolled acceleration of the motor ("overspeeding") is detected at an early stage. This limitation is necessary in order to avoid personal and material damage.

- Set parameter *Current limit* **728** of the speed controller to a lower current value (e. g. 10% of rated motor current). In this way it is made sure that there are no excessive currents of the offset is set incorrectly.
- Turn motor shaft manually. Check the sense of rotation of the encoder via the actual value of parameter *Encoder 2 Frequency* **219**. In the case of a clock-wise rotation of the motor shaft, positive values are displayed for the actual frequency value. If the displayed sense of rotation does not correspond to the actual sense of rotation, change the connections of tracks A and B.

The *Offset* **1188** must be between 0° and 360°, divided by the number of motor pole pairs. The possible range is between 0° and max. Offset.

$$\text{Max. Offset} = \frac{360°}{\text{Motor pole pairs}}$$

If the adjusted value is changed by the max. Offset, this does not affect the *Flux-Forming Voltage* **235**.

- Adjust a low reference speed value (approx. 10% lower than the *Frequency Switch-Off limit* **417**), and enable the frequency inverter via controller release and S2IND (start clock-wise operation) in order to accelerate the motor.
- If an overcurrent is detected or a fault message is issued due to an overload, the guided commissioning (setup) will start first. Confirm the machined data values. After completion of the guided commissioning, adjust the parameter *Current Limit* **728** to a low value again because this value was overwritten during the guided commissioning.

Depending on the behavior of the motor after start, carry out the following steps:

– **Motor does not turn, or the motor shaft only turns to a new position and stops again:**

- Check if parameter *No. of Pole Pairs* **373** has been set correctly for the motor.

If these values are adjusted correctly, take the following measures complying with the safety instructions.

Warning! When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Wait for some minutes until the DC link capacitors have discharged before starting to work at the unit.

- Before electrical installation work, de-energize the frequency inverter and take appropriate precautions to make sure it is not re-energized unintentionally. Make sure that the frequency inverter is discharged.
- Exchange two motor phases (e.g. U and V) at the frequency inverter terminals because the senses of rotation of the motor and the encoder do not correspond to each other.
- Switch on the power supply again.
- As described above, adjust a low speed reference value and start the motor.

If the motor does not start despite the phase exchange:

- Increase the parameter value for *Offset* **1188** by 90°, divided by the no. of motor pole pairs.

If the motor still does not turn, exchange the two motor phases (e.g. U and V) again.

– **The motor turns and accelerates until it reaches the** *Frequency Switch-Off limit* **417:**

  - Check the encoder lines and check the encoder connection contacts.
  - In the case of fault message "Overfrequency" F1100: increase the parameter value for *Offset* **1188** by 180°, divided by the no. of motor pole pairs.

– **If the motor turns at the adjusted speed and in the right direction, carry out the fine adjustment of the offset:**

  - Adjust the parameter value for *Offset* **1188** in small steps (e.g. 2.5°) until the *Flux-Forming Voltage* **235** is roughly 0.
  – In case the flux-forming voltage deviates from 0 significantly, adjust the offset in bigger steps.
  – In the case of a positive flux-forming voltage, increase the offset.
  – In the case of a negative flux-forming voltage, reduce the offset.
  - Adjust parameters *Frequency Switch-Off limit* **417** and *Current Limit* **728** to the required values.
  - Repeat the **fine adjustment** of the offset at 50 % of the rated frequency.

This completes the offset adjustment.

- Start the guided commissioning. This is required for optimum current control.

Attention! Some absolute value encoder types enable to "zero" or change the position transmitted by the encoder. Do not use this function, as this will change the commutation angle for *Offset* **1188** and correct speed control is not guaranteed.

8.4.7 Bits/Turn

If an absolute value encoder is used (EnDat 2.1, Hiperface, SSI), the number of Bits/Turn (referred to encoder) must be configured in the frequency inverter. In the case of Hiperface and SSI encoders, the value specified in the data sheet of the encoder used must be entered in parameter *Bits/Turn* **1271**.
In the case of EnDat 2.1, the value is read automatically from the EnDat encoder and used internally. Parameter *Bits/Turn* **1271** is not evaluated in the case of EnDat encoders.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1271	Bits/Turn	0 bits/t	32 bits/t	13 bits/t

Note: The internal resolution of one motor revolution is 16 bit. The resolution of *Bits/Turn* **1271** is converted to the internal resolution if the encoder is used as a motor encoder.
In the case of application encoders, the reference between motor and application encoder is parameterized through the gear factors *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514**.

Note: In the case of linear encoders, this value must be set according to chapter 6.6.

8.4.8 Bits Multiturn

If a multiturn absolute value encoder is used (EnDat 2.1, Hiperface, SSI), the number of Bits/Turn (referred to encoder) for the multiturn resolution must be configured in the frequency inverter. In the case of Hiperface and SSI encoders, the value specified in the data sheet of the encoder used must be entered in parameter *Bits Multiturn* **1272**. In the case of EnDat 2.1, the value is read automatically from the EnDat encoder and used internally. Parameter *Bits Multiturn* **1272** is not evaluated in the case of EnDat encoders.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1272	Bits Multiturn	0 Bit	32 Bit	13 Bit

Note: The position of the motor is resolved at a total of 31 bits + sign bit. The lower 16 bits are used for the motor position angle the higher 16 bits are used for the number of motor revolutions and the sign.

If the absolute value encoder is used as a motor encoder, the following shall apply:
If the number of *Bits Multiturn* **1272** is smaller than 16 bits, the missing bits are filled internally in the frequency inverter. These additional bits are used for overflow saving of the revolutions so that 2^{16} revolutions (including one sign bit) can be managed safe against zero voltage.
If the number of *Bits Multiturn* **1272** is greater than 16 bits, the accuracy of the encoder exceeds the accuracy of the inherent resolution of the frequency inverter.

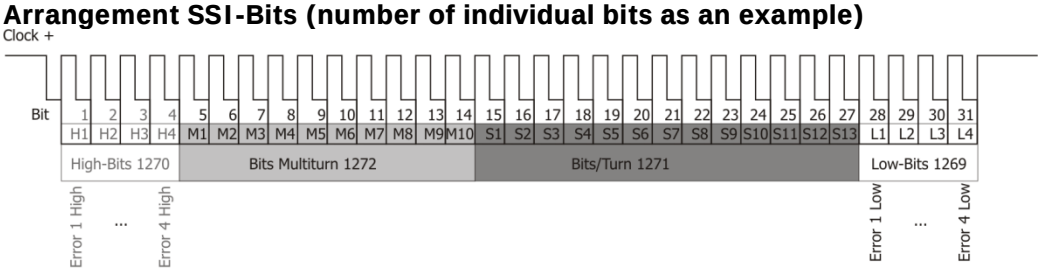
In the case of application encoders, the reference between motor and application encoder is parameterized through the gear factors *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514**.

Note: In the case of linear encoders, this value must be set according to chapter 6.6.

8.4.9 SSI: error/additional bits

If SSI encoders are used, the available error/additional bits of the encoder can be masked for evaluation. Many encoders use one or more bits for error signaling. In some cases, the bits are also used for transmitting additional information not required for encoder evaluation in the frequency inverter.

Arrangement SSI-Bits (number of individual bits as an example)



The number of bits is shown as an example in the illustration. Multiturn bits are only present in the case of Multiturn encoders. The additional bits "Low bits" are used by many encoder manufacturers with 1 or 3 bits. The additional "High bits" are only used very rarely by encoder manufacturers.

Depending on the function intended by the encoder manufacturer, an error bit "High" or "Low" may trigger an error.
Parameters **1269** *SSI: Error-/Extra Bits (Low)* and **1270** *Error-/Extra Bits (High)* can evaluate up to eight error bits each. SSI error MSBits is used for the definition the most significant bits, and SSI error LSBits is used for the less significant bits.
To determine the total data width, the two parameters must always be defined. This definition is also required if no evaluation is to take place. In this case, all bits must be masked as "Don't care" with an "X" in the string.
If no error bits or other bits are present ("empty string"), a dash "-" must be parameterized.

The following values are permissible:
H: When the bit is "High", error F172A or F172B will be triggered.
L: When the bit is "Low", error F172A or F172B will be triggered.
X: No error will be triggered for the bit, regardless of its status.
-: Number of bits = 0 (use in this case only).

Lowercase letters can be used alternatively in the entry.
Note: This parameter cannot be entered by means of KP500.
Note: Other values cannot be entered.

Special case: Number of bits = 0:
SSI additional bits in the High range are not used by many encoder manufacturers. In these cases set the parameter to value "-" (dash).

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1269	SSI: Error-/Extra-Bits (Low)	Special, see text		„-"
1270	SSI: Error-/Extra-Bits (High)			„-"

Note: Due to the shifting of the usable data by the error/additional bits, the number of error/additional bits must always be specified correctly.

8.4.9.1 Example 1

Additional bits (High)	Multiturn bits	Singleturn bits	Additional bits (Low)
0	8	16	Total 1 to be evaluated. "High" is an error situation.

SSI: Error-/Extra-Bits (High) **1270** = "-"
Bits Multiturn. **1272** = 8
Bits/Turn **1271** = 16
SSI: Error-/Extra-Bits (Low) **1269** = "-"

8.4.9.2 Example 2

Additional bits (High)	Multiturn bits	Singleturn bits	Additional bits (Low)
0	12	16	Total 4, the second one is to be evaluated. "Low" is an error situation.

SSI: Error-/Extra-Bits (High) **1270** = "-"
Bits Multiturn. **1272** = 12
Bits/Turn **1271** = 16
SSI: Error-/Extra-Bits (Low) **1269**= "XLXX"

8.4.9.3 Example 3

Additional bits (High)	Multiturn bits	Singleturn bits	Additional bits (Low)
Total 2, the first one is to be evaluated. "High" is an error situation.	8	16	Total 4, the second one is to be evaluated. "Low" is an error situation.

SSI: Error-/Extra-Bits (High) **1270** = "HX"
Bits Multiturn. **1272** = 8
Bits/Turn **1271** = 16
SSI: Error-/Extra-Bits (Low) **1269**= "XLXX"

8.4.9.4 Example 4

Additional bits (High)	Multiturn bits	Singleturn bits	Additional bits (Low)
0	8	16	Encoder has 4 toggle bits all of which are to be ignored.

SSI: Error-/Extra-Bits (High) **1270** = "-"
Bits Multiturn. **1272** = 8
Bits/Turn **1271** = 16
SSI: Error-/Extra-Bits (Low) **1269**= "XXXX"

8.4.10 SSI: Sampling interval

SSI frequency encoders often use a sampling rate in the millisecond range. In order for the evaluation in the device to work correctly, the sampling rate of the SSI absolute value encoder must be set up. If the sampling rate of the encoder cannot be adjusted, use the next higher, available setting. The parameter value is adjusted as a multiplier of 125 us.

Note: Not all steps from 0 to 240 are available. The selection list limits the available options to reasonable settings.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1268	SSI: Sampling interval	0	240	0

Attention: For a good positioning behavior, the sampling rate is to be less than 1 ms.
In the case of higher sampling rates, unwanted high system vibration or even machine damage may occur, if the speed and position controller are configured improperly.
In the case of high sampling rates (> 2 ms), reduce the dynamics of the system via the speed controller and the position controller.
Positioning accuracy will be lower in the case of high sampling rates. For precise applications, use encoders with low sampling rates.

8.4.11 Gear factor speed sensor 2

If the speed sensor is coupled to the motor via one or more gears, the transmission ratio between the motor and the encoder must be configured via *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514**.

Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
513	EC2 Gear Factor Numerator	-300.00	300.00	1.00
514	EC2 Gear Factor Denominator	0.01	300.00	1.00

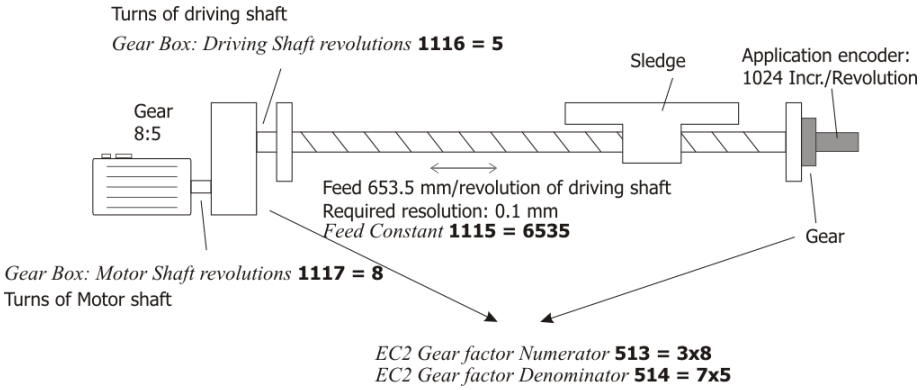
$$\frac{\text{Revolutions of the Motor shaft}}{\text{Revolutions of the EC2 encoder shaft}} = \frac{EC\ 2\ Gear\ Factor\ Numerator\ \mathbf{513}}{EC\ 2\ Gear\ Factor\ Denominator\ \mathbf{514}}$$

Note: Gear factors *EC2 Gear Factor Numerator* **513** and *EC2 Gear Factor Denominator* **514** must always be referred to the motor.

Note: In the case of linear encoders, this value must be set according to chapter 6.6.

8.4.11.1 Example

On a linear axis, the motor is flange-connected via a gear (transmission ratio 8:1) and the application connector is flange-connected via a second gear (transmission ratio 3:1).


Turns of driving shaft
Gear Box: Driving Shaft revolutions 1116 = 5
Sledge
Application encoder:
1024 Incr./Revolution
Gear
8:5
Feed 653.5 mm/revolution of driving shaft
Required resolution: 0.1 mm
Feed Constant 1115 = 6535
Gear
Gear Box: Motor Shaft revolutions 1117 = 8
Turns of Motor shaft
EC2 Gear factor Numerator 513 = 3x8
EC2 Gear factor Denominator 514 = 7x5

1 motor revolution = 1/8 turn on output side
= 1/8x3 encoder turn

$$\frac{EC\ 2\ Gear\ Factor\ Numerator\ \mathbf{513}}{EC\ 2\ Gear\ Factor\ Denominator\ \mathbf{514}} = \frac{\text{Revolutions of the Motor shaft}}{\text{Revolutions of the EC2 encoder shaft}} = \frac{8}{3}$$

8.4.12 Instructions on speed-controlled configurations (“Not x40”)

In the case of speed-controlled configurations, an encoder is typically installed. Normally, this encoder is connected to the motor.

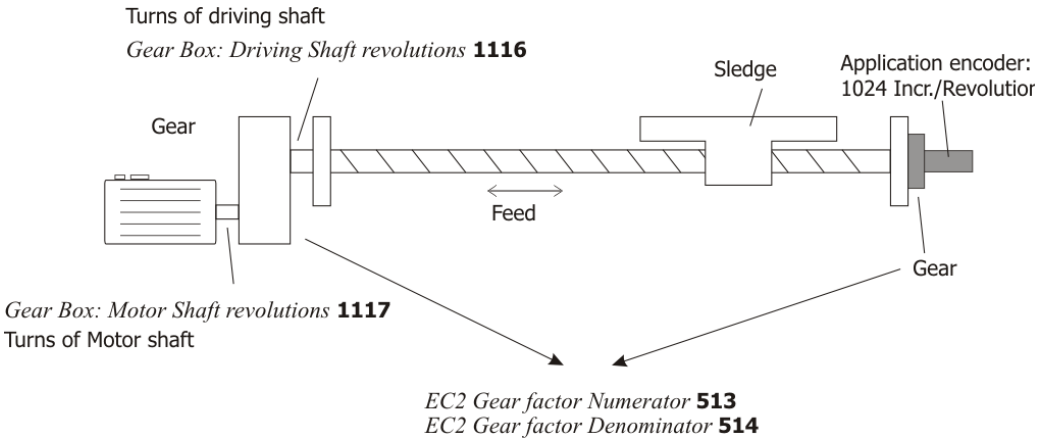
An internal format (referred to as 16/16) is used for speed control. The 16 less significant bits represent the position angle on a motor revolution, the 16 more significant bits represent the number of motor revolutions.

If absolute value encoders are used, the absolute value encoder notation is converted to the internal notation. This is why, for proper function, the parameters of the absolute value encoder must be entered in accordance with the data sheet. In the case of other parameterizations, unwanted malfunction of the drive might occur.

8.4.13 Instructions on positioning (configuration x40)

If positioning (configuration x40) and an absolute value encoder are used, a distinction is made for parameterization between "motor encoders" and "application encoders".
The motor encoder is always needed for speed control and can also be used for position control in the case of no-slip systems.
An application encoder for position control is used in systems where slip may occur for slip compensation. This encoder is also often referred to as an "External encoder" or "Synchronous encoder".
With the present EM-ABS-01 module, the following configurations are possible:

System slip	Motor type	Configuration
no-slip system, **high speed precision:** absolute value encoder at motor for speed control and position control	synchronous servomotor & asynchronous motor	540 & 240
no-slip system, **low speed precision:** absolute value encoder as application encoder for position control of motor model with speed control	synchronous servomotor	640
slipping system, **high speed precision:** absolute value encoder as application encoder for position control HTL encoder as motor encoder for speed control	asynchronous motor	240
slipping system, **low speed precision:** absolute value encoder as application encoder for position control motor model for speed control	synchronous servomotor & asynchronous motor	640 & 440



An internal format (referred to as 16/16) is used for speed control and calculation of the positioning trajectory. The 16 less significant bits represent the position angle on a motor revolution, the 16 more significant bits represent the number of motor revolutions.

The positioning offers the user so-called "user units" (abbreviation [u]), which enable adjustment to any application via the reference system. In this way, the resolution of the smallest unit for positioning can be parameterized (e.g. 1 mm, 4 mm, 0.01 °, etc.).
For more information on the reference system, refer to the application manual "Positioning".

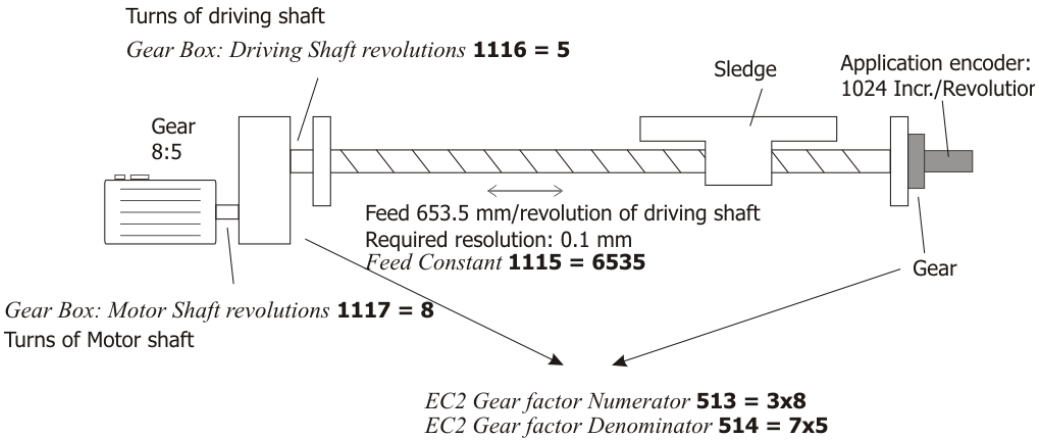
Parameters		Settings		
No.	**Description**	**Min.**	**Max.**	**Factory setting**
1115	Feed constant	1 u/U	2^{31}-1 u/U	65536 u/U
1116	Gear Box: Driving Shaft Revolutions	1	65 535	1
1117	Gear Box: Motor Shaft Revolutions	1	65 535	1

For application encoders, a gear transmission between the application encoder and motor must be parameterized via a gear factor (see chapter 8.4.11 "Gear factor speed sensor 2").

The conversions between the different reference systems are done automatically, the user sets the target values in user units referred to the distance.

8.4.13.1 Example

For parameterization of a linear slide, the following properties are known:
Motor gear ratio: 8:5
Application encoder gear ratio: 7:3
Feed rate of linear axis: 635.5 mm/revolution of the output shaft


Turns of driving shaft
Gear Box: Driving Shaft revolutions 1116 = 5
Sledge
Application encoder:
1024 Incr./Revolutior
Gear
8:5
Feed 653.5 mm/revolution of driving shaft
Required resolution: 0.1 mm
Feed Constant 1115 = 6535
Gear
Gear Box: Motor Shaft revolutions 1117 = 8
Turns of Motor shaft
EC2 Gear factor Numerator 513 = 3x8
EC2 Gear factor Denominator 514 = 7x5

This results in the following parameterization:
Feed constant **1115 =** 6535 rev
Gear shaft turns **1116** = 5
Gear motor turns **1117** = 8
EC2 Gear Factor Numerator **513** = 24
EC2 Gear Factor Denominator **514** = 35

In order to move by 1 mm, a positioning order of 10 u must be executed.

Note: In the case of linear systems, the feed constant is typically specified in the data sheet. If this value is unknown, it must be determined empirically. For empirical determination of the feed constant, refer to application manual "Positioning".

8.4.13.2 Homing

When it comes to positioning, homing may be required or recommended, depending on the application. If no absolute value encoder is used, homing to a known point (e.g. reference cam or limit switch) will typically be performed first upon restoration of mains supply.
When an absolute value encoder is used, homing during operation is unwanted in many situations. If homing is not to be performed during operation, you can set *Operation mode* **1228** = "10 – No homing".

By using different frequency inverter data sets, you can configure a setup mode, including homing, and a normal operation mode.

8.4.14 Warning Dig. Encoder

Via parameter *Warning Dig. Encoder* **1274**, the current warning status of EnDat 2.1 encoders is displayed. This information can be used for analyzing and eliminating application problems. Parameter *Warning Dig. Encoder* **1274** shows the current warning with an abbreviation. For evaluation via field bus, parameter *Warning Dig. Encoder* **1273** with the warning value in hexadecimal representation can be used. By addition of the values, several warnings can be displayed simultaneously.

EnDat 2.1 warnings			
Abbreviation in *Warning Dig. Encoder* **1274**	**Bit code** *Warning Dig. Encoder* **1273**		**Meaning**
	Bit	**Value**	
Fcoll	0	0x0001	Frequency collision
Temp	1	0x0002	Temperature exceeded
Illum	2	0x0004	Control reserve lighting
Batt	3	0x0008	Battery status
Ref	4	0x0010	Reference point

Warnings which are present at the same time are represented by the bit combination or mathematical addition.

Present warnings can be displayed via the application warning mask in Bit 9.

8.4.15 Act. speed source

The rotary encoder is selected via *Actual Speed Source* **766**. If the encoder is to deliver the actual value signal for the speed controller, rotary encoder 2 must be selected as the source. In the basic setting, rotary encoder 1 is used as the source of actual speed.

Actual speed source 766	Function
1 - Encoder 1	The actual speed source is speed sensor 1 of the basic device (factory setting).
2 - Encoder 2	The actual speed source is rotary encoder 2 of the EM-ABS-01 extension module.
3 - Motor model	The actual speed source is the motor model of the ACU.

Note: Setting "3-Motor model" is visible and available in configurations 440 and 640 only.

8.4.16 Actual position source

In positioning applications (configurations x40), the actual position source must be set. This is done via *Actual Position Source* **1141**. In the basic setting, the actual value source of the speed control is used as the actual position source.

Actual Position Source 1141	Function
0 - like 766 Actual speed source	The actual speed source is the actual position source at the same time (factory setting).
1 - Encoder 1	The actual position source is speed sensor 1 of the basic device.
2 - Encoder 2	The actual position source is rotary encoder 2 of the EM-ABS-01 extension module.

Note: In configuration 540, *Actual Speed Source* **766** is not visible and always set to speed encoder 2 (absolute value encoder input of EM-ABS-01).

8.5 Reference frequency and percentage value channel

The various functions for the statement of the reference figures are connected in the various configurations by the reference frequency or percentage value channel. The *Reference Frequency Source* **475** and the *Reference Percentage Source* **476** determine the additive connection of the available reference sources as a function of the installed hardware.

Operation mode	Function
2 - Abs. analog value EM-S1INA	Reference source is the analog input EM-S1INA.
4 - Abs. value MFI1A + EM-S1INA	Reference sources are the multifunctional input MFI1A and the analog input EM-S1INA.
14 - Abs. value MFI1A + EM-S1INA + FP *(or FF)*	Reference sources are the multifunctional input MFI1A, analog input EM-S1INA and fixed percentage FP *(or the fixed frequency FF).*
24 - Abs. value MFI1A + EM-S1INA + MP	Reference sources are the multifunctional input MFI1A, analog input EM-S1INA and the motor potentiometer function MP.
102 to 124	Operation modes with signs (+/-).

Alongside the operation modes listed, those stated in the operating instructions of the frequency inverter in the chapter "Frequency reference channel", and in the chapter "Percentage reference channel" also apply.

8.6 Actual value display

The actual value of rotary encoder 2 can be read out via the parameters *Encoder 2 Frequency* **219** and *Encoder 2 Speed* **220**.

The analog input signal on analog input EM-S1INA is displayed via actual value parameter *Analog Input EM-S1INA* **253**.

8.6.1 Absolute value encoder - raw data

For diagnosis, you can check the value transmitted by the absolute value encoder via parameter *Abs. Encoder Raw Data* **1267**.

Depending on the encoder technology used, the actual value parameter is built up as follows:

Hiperface

Position
Binary

EnDat 2.1

Position
Binary

SSI

Additional bits (High) :	Position	: Additional bits (High)
Binary	Binary raw (not converted)	Binary

Note: The colons are added in the case of (parameterized) SSI encoders for better readability in the display, they do not form part of the transmitted telegram.
The colons are added according to the configuration of parameters *SSI: Error-/Extra-Bits (Low)* **1269,** *SSI: Error-/Extra-Bits (High)* **1270** and *Bits/Turn* **1271**, *Bits Multiturn* **1272**.

Note: The positioning value in SSI is not valued. When it comes to diagnosis, consider the coding system used by the encoder (Gray code or binary code).

SinCos

SinCos encoders do not use absolute values. The actual value parameter remains empty.

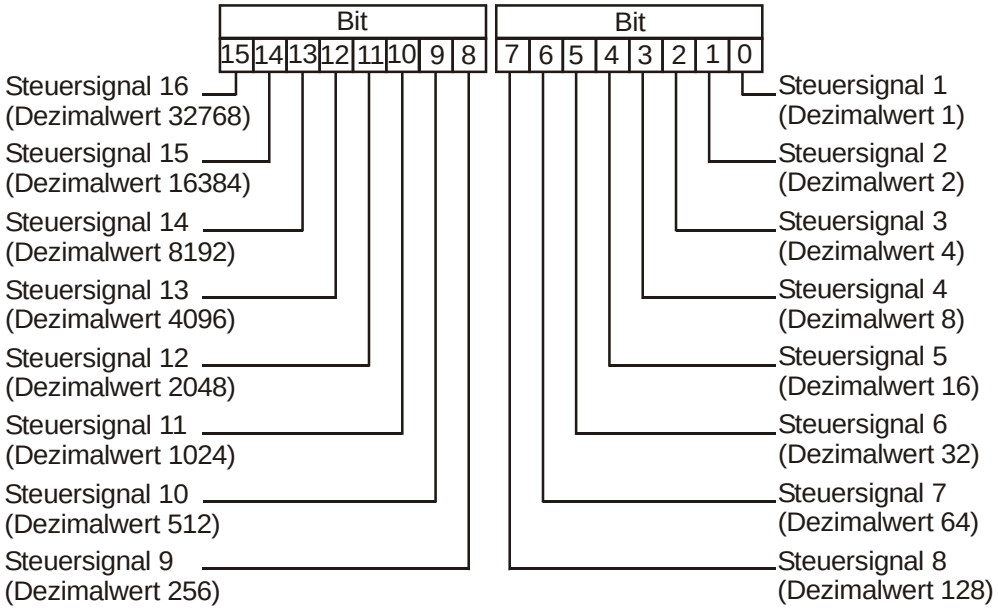
8.6.2 Actual position

Act. position **1108**
shows the current actual value (position) in user units [u] in positioning configurations x40.

8.7 Status of digital signals

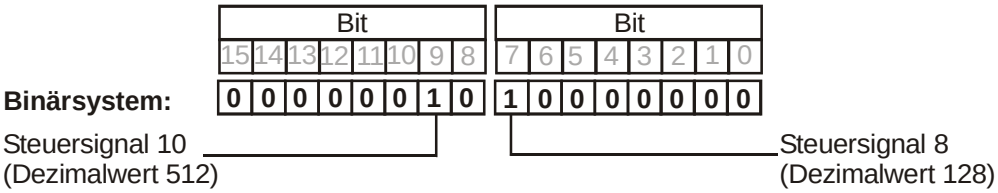
The status of the digital signals can be read (decimal coding) via parameter *Digital inputs* **250,** *Digital inputs (hardware)* **243** and *Digital outputs* **254** . The display of the digital input signals enables checking of the various control signals and their assignment to the corresponding software functions, in particular during commissioning.
After conversion of the decimal figure into the binary system, the bits 8, 9 and 10 dis-play the statuses of the inputs EM-S1IND, EM-S2IND and EM-S3IND.

Coding of the status of the digital signals


Bit
15 14 13 12 11 10 9 8
Bit
7 6 5 4 3 2 1 0
Steuersignal 16 (Dezimalwert 32768)
Steuersignal 15 (Dezimalwert 16384)
Steuersignal 14 (Dezimalwert 8192)
Steuersignal 13 (Dezimalwert 4096)
Steuersignal 12 (Dezimalwert 2048)
Steuersignal 11 (Dezimalwert 1024)
Steuersignal 10 (Dezimalwert 512)
Steuersignal 9 (Dezimalwert 256)
Steuersignal 1 (Dezimalwert 1)
Steuersignal 2 (Dezimalwert 2)
Steuersignal 3 (Dezimalwert 4)
Steuersignal 4 (Dezimalwert 8)
Steuersignal 5 (Dezimalwert 16)
Steuersignal 6 (Dezimalwert 32)
Steuersignal 7 (Dezimalwert 64)
Steuersignal 8 (Dezimalwert 128)

Example:

The actual value parameter *Digital inputs* **250** displays the decimal value **640**. After conversion into the binary system, the following combination results:


Bit
15 14 13 12 11 10 9 8
Bit
7 6 5 4 3 2 1 0
Binärsystem:
0 0 0 0 0 0 1 0
1 0 0 0 0 0 0 0
Steuersignal 10 (Dezimalwert 512)
Steuersignal 8 (Dezimalwert 128)

The following status of the digital input signals of the extension module was displayed:

- Digital input EM-S1IND = 1 – control signal 8
- Digital input EM-S2IND = 0 – control signal 9
- Digital input EM-S3IND = 1 – control signal 10

8.8 Motor temperature

The temperature monitoring is a part of the error and warning behavior which can be freely configured. The connected load can be monitored by the connection of a measurement resistor (motor PTC resistor / PTC) with a temperature characteristic to DIN 44081 or with a bimetallic temperature sensor (NC contact).

The operation mode of the motor PTC port can be selected via parameter *Motor Temp. Operation mode* **570** The operation modes described in chapter "Motor Temperature" of the frequency inverter operating instructions are complemented by the following operation modes with the extension module:

Operation mode	Function
11 - EM-MPTC: warning only	The critical point of operation is displayed by the control unit and parameter *Warnings* **269**.
12 - EM-MPTC: Fault shutdown	The fault shutdown is displayed by message F0400. The fault shutdown can be acknowledged via the control unit or the digital input.
13 - EM-MPTC: Fault shutdown 1 min del.	The fault shutdown according to operation mode 2 is delayed by one minute.
14 - EM-MPTC: Fault shutdown 5 min del.	The fault shutdown according to operation mode 2 is delayed by five minutes.
15 - EM-MPTC: Fault shutdown 10 min del.	The fault shutdown according to operation mode 2 is delayed by ten minutes.

The function to be adjusted by parameter *Motor Temp. Operation mode* **570** results in signaling the overtemperature by the red LED of the frequency inverter, irrespective of the selected operation modes of the control inputs and outputs.
The operation modes with error-switch-off result in the fault message "FAULT" with fault number "F0400" being displayed on the control unit KP500.
The fault message can be acknowledged via parameter *Program* **34** or the logic signal linked with parameter *Error acknowledgement* **103**.

9 List of parameters

The parameter list is structured according to the menu branches of the control unit. For better clarity, the parameters have been marked with pictograms:

The parameter is available in the four data sets.

☑ The parameter value is adjusted by the SETUP routine if a control method for a synchronous machine is selected for parameter *Configuration* **30**.

⊗ This parameter cannot be written when the frequency inverter is in operation.

9.1 Actual value menu (VAL)

Frequency inverter data				
No.	**Description**	**Unit**	**Display range**	**Chapter**
016	EM Software version			10.2
Actual values of machine				
No.	**Description**	**Unit**	**Display range**	**Chapter**
219	Encoder 2 Frequency	Hz	0,0 ... 999,99	8.6
220	Encoder 2 Speed	rpm	0 ... 60000	8.6
Actual values of frequency inverter				
253	Analog Input EM-S1INA	V	-10 ... +10	8.6
1108	Act. Position	u	Long	8.6.2
1267	Abs. Encoder Raw Data	-	String	8.6.1
1273	Warning Dig. Encoder	-	Word	8.4.14
1274	Warning Dig. Encoder	-	Selection	8.4.14

Note:
Parameter *Warning Dig. Encoder* **1273** is intended for read-out via a PLC, parameter *Warning Dig. Encoder* **1274** provides a brief description of the information in VPlus and the keypad KP500.

9.2 Parameter menu (PARA)

	No.	Description	Unit	Setting range	Chapter
	Repetition frequency output				
	509	Repetition frequency EM-S1/S2OUTD	-	Selection	8.2.3
	Digital outputs				
	513	EC2 Gear Factor Numerator	-	-300,00 ... 300,00	8.4.11
	514	EC2 Gear Factor Denominator	-	0,01 ...300,00	8.4.11
	Digital outputs				
	533	Op. Mode EM-S1OUTD	-	Selection	8.2.2
	534	Op. Mode EM-S2OUTD	-	Selection	8.2.2
	Analog input				
	560	Tolerance band	%	0,00 ... 25,00	8.1.5
	561	Filter time constant	-	Selection	8.1.8
	562	Operation Mode	-	Selection	8.1.3
	563	Error/Warning Behaviour	-	Selection	8.1.6
	564	Point X1	%	-100,00 ... 100,00	8.1.2
	565	Point Y1	%	-100,00 ... 100,00	8.1.2
	566	Point X2	%	-100,00 ... 100,00	8.1.2
	567	Point Y2	%	-100,00 ... 100,00	8.1.2
	568	Adjustment	-	Selection	8.1.7

No.	Description	Unit	Setting range	Chapter
	Speed controller			
766	Actual Speed Source	-	Selection	8.4.15
	System bus			
900	Node-ID	-	-1 ... 63	7.5
903	Baud-Rate	-	Selection	7.4
904	Boot-Up Delay	ms	3500 ... 50000	7.8.4
918	SYNC-Identifier	-	0 ... 2047	7.8.2
919	SYNC-Time	ms	0 ... 50000	7.9.2
921	RxSDO1-Identifier	-	0 ... 2047	7.9.5
922	TxSDO1-Identifier	-	0 ... 2047	7.9.5
923	SDO2 Set Active	-	Selection	7.9.5
924	RxPDO1 Identifier	-	0 ... 2047	7.11.1
925	TxPDO1 Identifier	-	0 ... 2047	7.11.1
926	RxPDO2 Identifier	-	0 ... 2047	7.11.1
927	TxPDO2 Identifier	-	0 ... 2047	7.11.1
928	RxPDO3 Identifier	-	0 ... 2047	7.11.1
929	TxPDO3 Identifier	-	0 ... 2047	7.11.1
930	TxPDO1 Function	-	Selection	7.11.2
931	TxPDO1 Time	ms	0 ... 50000	7.11.2
932	TxPDO2 Function	-	Selection	7.11.2
933	TxPDO2 Time	ms	0 ... 50000	7.11.2
934	TxPDO3 Function	-	Selection	7.11.2
935	TxPDO3 Time	ms	0 ... 50000	7.11.2
936	RxPDO1 Function	-	Selection	7.11.2
937	RxPDO2 Function	-	Selection	7.11.2
938	RxPDO3 Function	-	Selection	7.11.2
939	SYNC Timeout	ms	0 ... 60000	7.11.3
941	RxPDO1 Timeout	ms	0 ... 60000	7.11.3
942	RxPDO2 Timeout	ms	0 ... 60000	7.11.3
945	RxPDO3 Timeout	ms	0 ... 60000	7.11.3
946	TxPDO1 Boolean1	-	Selection	7.11.5.1
947	TxPDO1 Boolean2	-	Selection	7.11.5.1
948	TxPDO1 Boolean3	-	Selection	7.11.5.1
949	TxPDO1 Boolean4	-	Selection	7.11.5.1
950	TxPDO1 Word1	-	Selection	7.11.5.1
951	TxPDO1 Word2	-	Selection	7.11.5.1
952	TxPDO1 Word3	-	Selection	7.11.5.1
953	TxPDO1 Word4	-	Selection	7.11.5.1
954	TxPDO1 Long1	-	Selection	7.11.5.1
955	TxPDO1 Long2	-	Selection	7.11.5.1
956	TxPDO2 Boolean1	-	Selection	7.11.5.1
957	TxPDO2 Boolean2	-	Selection	7.11.5.1
958	TxPDO2 Boolean3	-	Selection	7.11.5.1
959	TxPDO2 Boolean4	-	Selection	7.11.5.1
960	TxPDO2 Word1	-	Selection	7.11.5.1
961	TxPDO2 Word2	-	Selection	7.11.5.1
962	TxPDO2 Word3	-	Selection	7.11.5.1
963	TxPDO2 Word4	-	Selection	7.11.5.1
964	TxPDO2 Long1	-	Selection	7.11.5.1
965	TxPDO2 Long2	-	Selection	7.11.5.1
966	TxPDO3 Boolean1	-	Selection	7.11.5.1
967	TxPDO3 Boolean2	-	Selection	7.11.5.1
968	TxPDO3 Boolean3	-	Selection	7.11.5.1
969	TxPDO3 Boolean4	-	Selection	7.11.5.1
972	TxPDO3 Word1	-	Selection	7.11.5.1
973	TxPDO3 Word2	-	Selection	7.11.5.1

No.	Description	Unit	Setting range	Chapter
974	TxPDO3 Word3	-	Selection	7.11.5.1
975	TxPDO3 Word4	-	Selection	7.11.5.1
976	TxPDO3 Long1	-	Selection	7.11.5.1
977	TxPDO3 Long2	-	Selection	7.11.5.1
989	Emergency Reaction	-	Selection	7.8.3

		Position controller			
☑⊗	1115	Feed Constant	u/U	1 ... 2^{31}-1	6.6 1)
☑⊗	1116	Gear Box: Driving Shaft Revolutions	-	1 ... 65535	
☑⊗	1117	Gear Box: Motor Shaft Revolutions	-	1 ... 65535	
	1141	Actual Position Source	-	Selection	8.4.16 1)

1) For further information, please refer to the application manual "Positioning".

	Encoder interface				
	No.	Description	Unit	Setting range	Chapter
	1183	Division marks	-	0 ... 8192	8.4.1
⊗	1184	Tracks/Protocol	-	Selection	8.4.2
	1186	Power supply	-	Selection	8.4.3
	1187	Supply voltage	V	5,00 ... 12,0	8.4.4
	1188	Offset	°	-360,0 ... 360,0	8.4.6
	1189	Abs. Encoder: Filter time constant	µs	125 ... 8000	8.4.5
	1268	SSI: Sample time	-	Factor (x 125 us)	8.4.10
	1269	SSI: Error-/Extra-Bits (Low)	-	Special	8.4.9
	1270	SSI: Error-/Extra-Bits (High)	-	Special	8.4.9
	1271	Bits/Turn	Bits/t	0 ... 32	8.4.7
	1272	Bits Multiturn	Bit	0 ... 32	8.4.8

10 Annex

10.1 Recommended encoder settings

Please note that the settings described in the following are only recommendations for standard variant of the relevant encoders. Owing to the great number of encoder types and special solutions not documented publicly, Bonfiglioli Vectron will not accept any responsibility for the settings specified. When it comes to setup, always refer to the encoder manufacturer's data sheet.

In the case of synchronous servomotors, the *Offset* **1188** must be set up according to chapter 8.4.6 "Offset".

10.1.1 SinCos encoders:

Encoder	B.C.	1183	1184	1186	1187	1271	1272	1270
Heidenhain ERN 1387 Variante: 2048 Ampl.	S1	2048	700	1)	5,0 V	2)	2)	2)
Heidenhain ERN 1185 Variante: 512 Ampl.	S2	512	700	1)	5,0 V	2)	2)	2)
Heidenhain ERN 1185 Variante: 2048 Ampl.	S3	2048	700	1)	5,0 V	2)	2)	2)

B.C. = Bonfiglioli Code used at motors of series BCR & BTD.
1) Please refer to chapter 8.4.3 for setup of parameter *Power supply* **1186**.
2) Not evaluated due to the *Tracks/Protocol* **1184** settings chosen.

Note: Owing to the great number of encoder types and special solutions not documented publicly, Bonfiglioli Vectron will not accept any responsibility for the settings specified.

10.1.2 Hiperface encoders:

Encoder	B.C.	1183	1184	1186	1187	1271	1272	1270
Sick SRS50	H1	1024	3109	1)	8,0 V	15	0	2)
Sick SRM50	H2	1024	3109	1)	8,0 V	15	12	2)
Sick SKS36	H3	128	3109	1)	8,0 V	12	0	2)
Sick SKM36	H4	128	3109	1)	8,0 V	12	12	2)
Sick SEK37	H5	16	3109	1)	8,0 V	9	0	2)
Sick SEL37	H6	16	3109	1)	8,0 V	9	12	2)
Sick SEK52	H7	16	3109	1)	8,0 V	9	0	2)
Sick SEL52	H8	16	3109	1)	8,0 V	9	12	2)

B.C. = Bonfiglioli Code used at motors of series BCR & BTD.
1) Please refer to chapter 8.4.3 for setup of parameter *Power supply* **1186**.
2) Not evaluated due to the *Tracks/Protocol* **1184** settings chosen.

Note: Owing to the great number of encoder types and special solutions not documented publicly, Bonfiglioli Vectron will not accept any responsibility for the settings specified.

10.1.3 EnDat2.1 encoders:

Encoder	B.C.	1183	1184	1186	1187	1271	1272	1270
Heidenhain ECI 1319	D1	32	1101	1)	5,0 V	3)	3)	2)
Heidenhain EQI 1331	D2	32	1101	1)	5,0 V	3)	3)	2)
Heidenhain ECN 1113	D3	512	1101	1)	5,0 V	3)	3)	2)
Heidenhain EQN 1125	D4	512	1101	1)	5,0 V	3)	3)	2)
Heidenhain ECN 1313 Variante: 512 Ampl.		512	1101	1)	5,0 V	3)	3)	2)
Heidenhain ECN 1313 Variante: 2048 Ampl.		2048	1101	1)	5,0 V	3)	3)	2)
Heidenhain EQN 1325 Variante: 512 Ampl.		512	1101	1)	5,0 V	3)	3)	2)
Heidenhain EQN 1325 Variante: 2048 Ampl.		2048	1101	1)	5,0 V	3)	3)	2)

B.C. = Bonfiglioli Code used at motors of series BCR & BTD.
1) Please refer to chapter 8.4.3 for setup of parameter *Power supply* **1186**.
2) Not evaluated due to the *Tracks/Protocol* **1184** settings chosen.
3) Parameters *Bits/Turn* **1270** and *Bits Multiturn* **1271** are not evaluated due to the setting of *Track signal* **1184**=1101. The values are applied directly from the EnDat 2.1 encoder.

Note: Owing to the great number of encoder types and special solutions not documented publicly, Bonfiglioli Vectron will not accept any responsibility for the settings specified.

10.1.4 SSI encoders, rotary:

Due to the great number of SSI encoder variants, only an extract of specifications can be shown here. Please refer to the encoder manufacturer's data sheets for the parameter settings.

Encoder / Parameter	1183	1184	1186	1187	1271	1272	1268	1269	1270
Sick AFM60B-BxPC032768 (without incremental track)	32768	50xx	1-internal	5.0 V	15	12	125 us	HHH	-
Kübler Sendix 5863 (with SinCos track)	2048	61xx	1-internal	5.0 V	17	12	125 us	-	-
Sick AFM60B-TxKx001024 (SinCos)	1024	61xx	1-internal	5.0 V	10	12	125 us	HHH	-

1) Please refer to chapter 8.4.3 for setup of parameter *Power supply* **1186**.

Note: Owing to the great number of encoder types and special solutions not documented publicly, Bonfiglioli Vectron will not accept any responsibility for the settings specified.

10.1.5 SSI encoders, linear encoders:

Encoder	1183	1184	1186	1187	1271	1272	1268	1269	1270
Leuze AMS304i 1120	---	50xx	1 [2)]	5.0 V	24 Bit distributed [3)]		2	H [4)]	-
Sick DME4000-111	---	50xx	1 [2)]	5.0 V	24 Bit distributed [3)]		8	H	-
Vahle LIMAX2S-03-050-1000-SSG0-U	---	50xx	1 [2)]	5.0 V	24 Bit distributed [3)]		16	H	-

1) Please refer to chapter 8.4.3 for setup of parameter *Power supply* **1186**.
2) Due to the high power consumption, this encoder requires an external power supply. In this case, set *Power supply* **1186** = "1-Internal" and connect the encoder to an external power supply.
3) For setup of this parameter, refer to chapter 6.6.
4) Note behavior changeable via encoder parameters.

Note: Owing to the great number of encoder types and special solutions not documented publicly, Bonfiglioli Vectron will not accept any responsibility for the settings specified.

10.2 Compatibility list

The compatibility between Module Firmware and device Firmware is described in the following.

ACU Firmware	EM-ABS-01 Firmware 1.0.1.0	EM-ABS-01 Firmware 2.0.1.0
5.0.x	Invalid Combination	Invalid Combination
5.1.x	Invalid Combination	Invalid Combination
5.2.0	Possible combination	Invalid Combination
5.3.0	Invalid Combination	Possible combination

The ACU Firmware can be read out via *Inverter Software Version* **012** and the Module Firmware via *EM Software version* **016**.

10.2.1 Module Firmware 1.0.1.0

The Module Firmware 1.0.1.0 requires basic device Firmware 5.2.0.

The following encoders are supported:

- SinCos
- Hiperface
- EnDat 2.1 (with SinCos tracks)

Limitations:

- In basic device firmware 5.2.0 several parameters of this operating instructions are not included.

Note: An operation of modules with firmware 1.0.1.0 is only valid with devices with firmware 5.2.0.
Devices with deviating device firmware may only be operated with EM-ABS-01 modules firmware 1.0.1.0 after written confirmation through Bonfiglioli.

10.2.2 Module-Firmware 2.0.1.0

The Module Firmware 2.0.1.0 requires basic device Firmware 5.3.0.

The following encoders are supported:

- SinCos
- Hiperface
- EnDat 2.1 (with SinCos tracks)
- SSI

Note: An operation of modules with firmware 2.0.1.0 is only valid with devices with firmware 5.3.0.
Devices with deviating device firmware may only be operated with EM-ABS-01 modules firmware 2.0.1.0 after written confirmation through Bonfiglioli.

10.3 Error messages

The various control methods and the hardware of the frequency inverter includes functions which continuously monitor the application. As a supplement to the messages documented in these operating instructions, the following failure keys are activated by the EM-ABS-01 extension module.

Error messages and repair		
F04	00	Motor temperature too high or temperature evaluation connection defective. Check cables and connections.
F14	80	Error during EM module initialization. Initialization of extension module failed. Check if extension module is plugged in correctly.
	81	EM-module communication failure. Communication between extension module and frequency inverter is faulty. Check EMC.
	82	General EM module error. Error on extension module. One of the following errors F1483 … F1493 has occurred.
	83	EM-ABS-01: No ext. 24V. Via parameter *Power supply* **1186**, an operation mode using an external power supply was selected, but there is no external voltage. Connect external power source or change operation mode.
	84	EM-ABS-01: Ext. 24V voltage level too low. The voltage level of the external power supply is too low or the external power supply is overloaded. Check the voltage level of the external power supply.
	85	EM-ABS-01: Int. 24V voltage level too low. The internal power supply to the encoder provided by the frequency inverter is overloaded. Check the connections at the control terminals.
	86	EM-ABS-01: No sense line. – Via parameter *Power supply* **1186**, an operation mode using a sense measuring line was selected, but no sense line is connected. Connect sense measuring line or select another operation mode. – Sense measuring line defective or broken. Check cables and connections.
	87	EM-ABS-01: A/B track missing. A/B track not found. Connect A/B track. A/B track cable broken. Check cables and connections. Check set *Division marks* **1183**. In some cases, you may have to reset the device if the error occurs directly after connection of mains supply.
	88	EM-ABS-01: Fault correction A/B track. Error during evaluation of A/B track. Required measuring accuracy not reached. The offset and amplification error correction for the A/B track has reached its maximum.

Error messages and repair		
	90	EM-ABS-01: Fault correction C/D track. Error during evaluation of C/D track. Required measuring accuracy not reached. The offset and amplification error correction for the C/D track has reached its maximum.
	91	EM-ABS-01: No R-track. Reference truck not found. – Via parameter *Tracks/Protocol* **1184**, an operation mode using a reference track was selected, but no reference track is connected. If available, connect the reference track or select another operation mode. – The settings of parameter *Division marks* **1183** does not match the type-specific division marks of the encoder. Check settings. – R track defective or cable broken. Check cables and connections.
	92	EM-ABS-01: Counting error. – Encoder evaluation is faulty. Check EMC. – The settings of parameter *Division marks* **1183** does not match the type-specific division marks of the encoder. Check settings.
	93	EM-ABS-01: Broken cable. Collective fault message. At least two of the following errors have occurred: – F1486 EM-ABS-01 "No sense line" – F1487 EM-ABS-01 "No A/B track" – F1489 EM-ABS-01 "No C/D track"
	95	EM-ABS-01: Position monitoring. A non-permissible deviation between the position value of the digital encoder interface and the analog A/B track has occurred
F17	01	Dig. encoder: encoder lighting. Encoder lighting has failed or reached the end of its service life
	02	Dig. encoder: Signal amplitude The amplitude of the signals used for the encoder-internal position calculation is outside of the permissible range.
	03	Dig. encoder: Position value. The digital position value is incorrect
	04	Dig. encoder: Overvoltage. Encoder supply voltage too high
	05	Dig. encoder: Undervoltage. Encoder supply voltage too low
	06	Dig. encoder: Overcurrent Encoder supply current too high
	07	Dig. encoder: battery Encoder battery is empty or has reached the end of its service life
	17	Dig. encoder: Error upon initialization Initialization of encoder failed. P. 262 contains the code of the error that occurred during initialization.
	18	Dig. encoder: Watchdog reset A watchdog reset was triggered in the encoder.
	19	Dig. encoder: Protocol error Error in communication with encoder. P. 262 contains the code of the error that occurred.
	20	Dig. encoder: Electronic Typeplate Error during access to el. type plate. The el. type plate is faulty or not available. P. 262 contains the code of the error that occurred.
	21	Dig. encoder: Overspeed Error caused by overspeed.

	22	Dig. encoder: Transmitter current Transmitter current in critical range.
	23	Dig. encoder: Overtemperature Encoder temperature too high
	24	Dig. encoder: timeout Communication between EM-ABS-01 and encoder resulted in a timeout error.
	25	Dig. encoder: CRC error Communication between EM-ABS-01 and encoder resulted in a CRC error.
	2A	Dig. encoder: SSI error bits (Low) Error bit of SSI encoder according to *SSI: Error-/Extra-Bits (Low)* **1269** is set.
	2B	Dig. encoder: SSI error bits (High) Error bit of SSI encoder according to *SSI: Error-/Extra-Bits (High)* **1270** is set.
	2C	Dig. encoder: SSI transmission error 1 A SSI encoder transmission error has occurred.
	2D	Dig. encoder: SSI transmission error 2 A SSI encoder transmission error has occurred.
F21	nn	Fault report to system bus master in fault in system bus slave nn = Node ID of slave (hex)
F22	00	Communication fault, system bus, timeout SYNC telegram
	01	Communication fault, system bus, timeout RxPDO1
	02	Communication fault, system bus, timeout RxPDO2
	03	Communication fault, system bus, timeout RxPDO3
	10	Communication fault, system bus, bus OFF

Note:
The error messages described above may occur depending on the encoder connected. Not every error message will be used for every encoder system.

Additional fault messages are described in the Operating instructions of the frequency inverter.
In addition to fault messages mentioned, there are further fault messages. However these messages are only used for internal purposes and are not listed here. If you receive fault messages which are not listed here, please contact Bonfiglioli.

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